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To the solid ground

Of nature trusts the Mind that builds for aye" —WORDSWORTH

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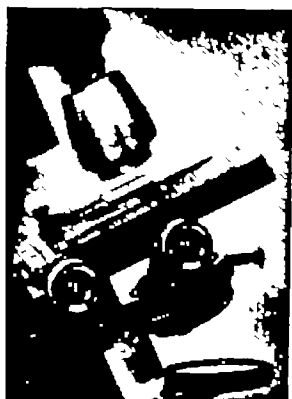
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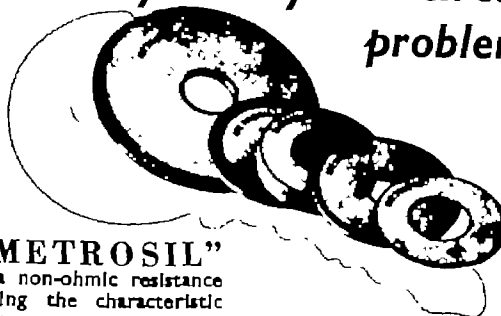
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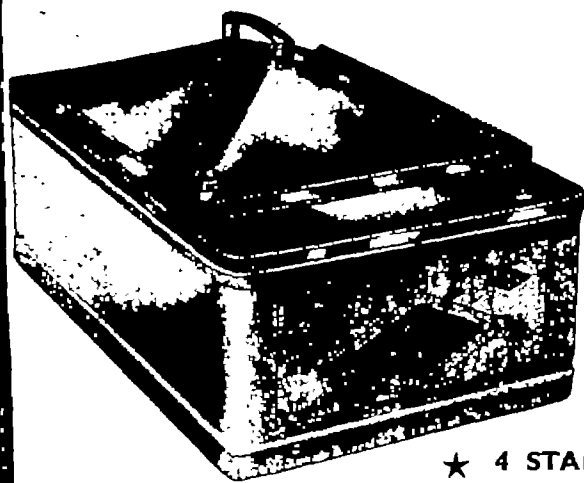
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Recent Scientific and Technical Books

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SCIENCE TEACHERS IN SCHOOLS

THE difficulties which many schools in Great Britain are experiencing in obtaining adequate staff for the science side are now becoming widely known. Reference has been made to this topic in these columns on many occasions during the past twelve months, and some general considerations on the implications of the shortage formed the subject of an article in *Nature* of December 19. The latest discussion on the subject was one arranged by the Federation of British Industries (see p. 196).

Just over a year ago, the actual staffing position in the schools was discussed (*Nature*, December 27, 1952), particularly as it affected the public and grammar schools. At that time there were about two hundred science posts unfilled; the close balance between supply and demand led to frequent staff changes and so there was little continuity of science teaching; the quality of both the academic and teaching ability of science teachers appeared to be lower than it was before the Second World War, and since 1950 the position was getting worse rather than better. This shortage in number and quality was ascribed to two main causes: there were not enough scientists to meet the post-war demands of industry, the Scientific Civil Service, the universities and the teaching profession; the pay of science teachers and their conditions of service compared unfavourably both with what they enjoyed before the War and with what they could now get in the other occupations open to them.

Since then, the Science Masters' Association and the Association of Women Science Teachers, and very recently the National Advisory Council for the Supply and Training of Teachers*, have issued reports on the problem. The National Advisory Council bases its conclusions on statistics obtained by the Ministry of Education and gives the administrative point of view; the teachers' associations describe the situation in the schools and reflect the front-line point of view; so the two reports are complementary.

The Council's report embraces not only public and grammar schools, but also technical and secondary modern schools and establishments of further education. It estimates that, between 1950 and 1955, 570 new science teachers will be available each year to meet an annual demand of 580 teachers. The post-war increase in birth-rate will increase the number of children in the grammar, technical and secondary modern schools from 2,000,000 in 1950 to 2,700,000 in 1960, and so the annual demand for science teachers during 1955-60 will rise to 1,020, if 1950 staffing standards are to be maintained. The Council notes that there is at present a shortage of science teachers, and that the quality of degree of the present science teachers is below its pre-war standard. It adds that the shortage will be very serious between 1955 and 1960 unless the supply of science teachers can be about doubled, by 1955. The

* Ministry of Education. Graduate Teachers of Mathematics and Science: a Report of the National Advisory Council on the Training and Supply of Teachers. Pp. iv+12. (London: H.M. Stationery Office, 1953.) 6d. net.

annual demand will fall to 380 in 1960, because the number of children in the schools will quickly decrease to its present number of 2,000,000 again. Hence, if the science teaching staff be doubled, in 1960 a number of teachers will become available for new vacancies. The Council concludes, therefore, that the serious problem is a short-term one and will be ended by about 1960, if the 1955-60 needs are met. It traces the present shortage of science teachers to three causes: the universities are not producing enough science graduates to satisfy the demands of industry, research in the universities, the Scientific Civil Service, and teaching; the pay of science teachers is inadequate; and the equipment of school laboratories and the supply of laboratory assistants are inadequate. The Council concludes by stressing that the shortage of school science teachers is not only a matter of serious concern to the schools but also to the whole nation. If it is not remedied, it will in due course decrease the number and quality of science students entering the universities, which, in turn, means that the output from the universities will fall at a time when it is essential that it should rise, to maintain and improve the standard of life in Britain. If the schools are starved of science teachers, this better supply of scientists will not be forthcoming, and the standard of life will go down at a steadily increasing rate.

The Science Masters' Association survey supports the facts in the National Advisory Council's report, and underlines the urgency of the position and the need for prompt action to remedy it. The Survey states that 115 science posts are vacant; as replies came from just over half the schools, there are probably two hundred vacant posts altogether. In eighty-four schools the teaching of one of the science subjects, physics, chemistry or biology, has been discontinued; in 1950 a report by the Incorporated Association of Headmasters noted that forty-eight schools had discontinued a subject. Both the academic and teaching ability of new science teachers is reported to be lower than it was before the War. Ten per cent of the science teachers are either non-graduates or arts graduates. Because the balance between supply and demand is so even, there is a constant movement of science staff, thus destroying the continuity of teaching in any one school. There would be many more vacant posts but for the existence of makeshift arrangements such as teachers continuing after the age of sixty-five, part-time teachers over sixty-five, part-time married women, two schools sharing the same teacher for a sixth-form science subject, and headmasters doing almost as much teaching as an assistant master. Finally, in the past ten years, 975 science teachers have left the schools either for industry or administration. The position in girls' schools is even worse than in boys' schools. Last autumn a survey by the Association of Headmistresses confirmed these facts.

The consequences of the shortage of school science teachers are now beginning to be felt. There are reports that places in university engineering schools and in hospital medical schools were unfilled at the start of the present academic year; science examiners

marking Advanced Level papers for the General Certificate of Education state that many candidates know the subject by heart without understanding it; and the quality of assistant experimental officers in the Scientific Civil Service, who are of the same standard, recruited by the Ministry of Supply is declining.

The National Advisory Council makes four main recommendations for remedying the shortage of science teachers. As the problem arises because there are not enough scientists to go round, the Council asks for a conference at the highest government level to discuss ways of securing a more equitable distribution of the available scientists among the various occupations needing them. The Council then states that pay is a major factor in the situation, but feels it cannot properly pursue this further as the pay of teachers is settled by another statutory body, the Burnham Committee. It also suggests that the output of science specialists leaving the schools for the universities could be increased with the present strength of science staff, as there are still a number of science sixth forms which could be doubled in size without overburdening the teachers. Finally, it suggests that the 'glamour' of research should be counteracted by putting the case for teaching as a satisfying career to undergraduates in the pure science departments of the universities.

The National Advisory Council is to be congratulated on its objective and restrained presentation of the situation, the seriousness of which for the whole nation it has correctly appraised. Its first remedy should be implemented without delay; it has said all it properly can about pay, but it is significant that the new salary scales which the Burnham Committee has recommended to the Minister of Education for adoption from April 1, 1954, have been rejected by the associations representing the headmasters and assistant masters of grammar schools. But is the Council right in thinking that the supply of science undergraduates can be increased with the present science teacher strength? The Science Masters' Association report shows that there are about twice as many boys in science sixth forms as there were before the War, while it is likely that the number of science teachers has only increased by ten per cent in the same time. There are many small science sixth forms in spite of the fact that the schools have made known to their pupils the great demand for scientists. Are not these small science sixth forms due partly to the fact that some of the science teachers are of such moderate ability and personality that they cannot attract any more pupils to their side of the school, and partly to the fact that, where the teacher is competent, he has already attracted all the pupils capable of doing sixth-form science? Finally, the Council has surely made a faulty diagnosis of the situation in judging it to be a short-term problem. On its own admission, it will only be a short-term problem provided the needs of 1955-60 are met, which means doubling the present supply of science teachers between 1955 and 1960. But the Council has no practical proposals for doubling the supply of science teachers by 1955 and

gives no evidence for believing that this can or will be done. If it is not done, the shortage in 1960 will be worse than it is now, because the number and quality of science graduates will have started seriously to decline; and the position will deteriorate at an increasing rate in schools, universities and industry.

It is difficult to resist the conclusion that the National Advisory Council is running away from the problem, the seriousness of which both for the schools and the nation it has so clearly stated. Why cannot the Council accept and act on the logical consequences of that statement? The shortage concerns the whole nation, because it threatens the supply of scientists and technologists essential to its well-being. The grammar schools in Britain are the main source of scientists and technologists. Surely, then, the development of secondary modern schools must take second place until the grammar schools have been made safe, so that they can satisfy the various demands for science graduates and ultimately the demand for them from the secondary modern schools themselves. At the moment, Great Britain is carrying an unprecedented load for defence in peace-time. While the resources available for education are severely limited, it is essential that the grammar schools, which are entrusted with the development of the talent of the ablest children in the country, should not be starved. They have already shown that they can carry out this task with some measure of success, and their products are in great demand for tasks of vital national importance. Their needs must be given priority in the educational system of Great Britain.

Once this decision has been taken, the way will then be clear for grappling with the problem of the present shortage in numbers and decline in quality of science teachers in the grammar schools. The solution of this problem will involve another difficult decision about the salary scales of all teachers in grammar schools. If these two issues are shirked, the Butler Act, which began by promising secondary education for all, may well in fact end by destroying the secondary education for the able children which did exist before the War in the grammar schools of Britain. The first of these two issues lies within the province of the National Advisory Council, and it should give the Minister of Education unequivocal advice on the matter.

SIR HANS SLOANE AND THE BRITISH MUSEUM

Sir Hans Sloane and the British Museum

By G. R. de Beer. (Published for the Trustees of the British Museum.) Pp. 192+11 plates. (London: Oxford University Press, 1953.) 18s. net.

IT was unfortunate that the week of the Coronation of Her Majesty coincided with, and took attention from, the centenary of another event of national importance, namely, the foundation of the British Museum. That term rightly includes not only the

vast collection at Bloomsbury but also the no less important Natural History collection at South Kensington. The British Museum was founded by Act of Parliament passed on June 7, 1753, as the direct result of the design of Sir Hans Sloane, who died a few months earlier in his tenth decade. He left his immense collections to the nation, desiring that they be used for public enjoyment and instruction and kept together "to the manifestation of the glory of God, the confutation of atheism and its consequences, the use and improvement of physics, and other arts and sciences, and the benefit of mankind". Parliament decided to combine with it two other considerable collections then available into one great national institution.

Of these collections, that of Sloane was by far the largest and most diverse. This fact and the action of the trustees named in his will, who brought the matter to the attention of Parliament, make this great physician the real founder of our national museum. Its two branches are rightly controlled by the same standing committee, thus emphasizing that any separation between the humanities and those other arts that we are accustomed to call the 'sciences' is but accidental, artificial and temporary, and that in many regions they do, in fact, overlap. This is wholly in accord with the feelings and outlook of the founder. The actual physical separation of the two types of objects was not effected for another century. It was in 1856 that the greatest of British comparative anatomists, Richard Owen (1804-92), was called as first director to South Kensington. It may well be that there is, for all institutions, an optimum size beyond which growth is harmful rather than helpful. Nevertheless, the separation of the 'sciences' from the 'arts' is a misfortune which Sloane himself foresaw and one which the present cordial relations of the two great branches of our national museum are now doing much to remedy.

Hans Sloane was born at Killyleagh, County Down, Ireland, in 1660. The name Hans—a shortened form of Johannes or John—implies no German relationship but was, it would appear, a Scottish-Irish form used at that time. He came of a fairly well-to-do family and seems never to have been in want. At nineteen years of age he came to study in London, and there he met and made friends with the illustrious naturalist, John Ray (1627-1705), and the equally illustrious chemist, Robert Boyle (1627-91). Both men influenced him deeply. After four years he left for further study in France, where he attended medical, botanical, chemical and anatomical lectures in Paris and Montpellier, but took his degree, for no very evident reason, at the obscure and now extinct University of Orange in Provence. He returned to London in 1684 and called on Thomas Sydenham (1624-89), the "English Hippocrates", with a letter from Boyle recommending him as skilled in scholarship, botany and anatomy. Sydenham read the letter, looked at the young man and said: "That is all mighty fine, but it won't do—Anatomy, Botany—Nonsense! Sir, I know an old woman in Covent Garden who understands botany better, and as for anatomy, my butcher can dissect a joint full as well; no, young man, all this is Stuff: you must go to the bedside; there alone you can learn disease".

Nevertheless, the two became fast friends. Sloane went to the bedside and became, beyond doubt, one of the most effective practitioners of his day, for,

despite the unscientific state of medicine, he was a very careful observer and had just that calm and cautious yet optimistic temperament that inspires hope and confidence in the patient. He disliked complex prescriptions, preferred to try one remedy at a time and was deeply aware of the influence of the mind on disease. In all circumstances and in any age he would have been a first-class physician.

All this is admirably told in this attractive little book by Dr. G. R. de Beer, the present director of the British Museum (Natural History). In 1687 Sloane sailed for the West Indies in the suite of the Duke of Albemarle, Governor of Jamaica. He spent some sixteen months in that island, and his report on its natural history is a classic. He returned to practise in London, occupying his spare time in accumulating, arranging and cataloguing his collections which, in course of time, became extensive. In 1695 he married and settled at 3 Bloomsbury Place, where he practised for many years. In 1712 he became physician to Queen Anne and in 1706 physician-general to the Army. In 1716 he was made a baronet, being the first medical man to receive that title. In 1719 he became president of the Royal College of Physicians, and in 1727, on the death of Newton, succeeded him as president of the Royal Society. Among his medical activities is his physiciancy of Christ's Hospital for thirty-six years, his assistance to Captain Coram (1688-1751) in instituting the Foundling Hospital in 1739, and his attempt to establish a free dispensary. He practised until he was eighty-two, when he retired to Chelsea, where he died and was buried eleven years later.

The number and variety of the collections accumulated by Sloane is truly astonishing. There were about 50,000 printed books that formed the basis of the British Museum Library, about 3,800 volumes of manuscripts, about 32,000 medals and coins, 334 volumes of dried plants which formed the basis of the British Museum Herbarium, 12,500 other specimens of plants, 5,500 insects, 1,900 quadrupeds, 1,500 fishes, 1,200 birds, and thousands of other specimens under other headings. Some idea of the variety of the collection can be gathered from a special issue of the *British Museum Quarterly* that appeared last June as a special bicentenary number. In the articles by keepers of various departments, under the general charge of the director and principal librarian, Sir Thomas Kendrick, details may be learned of the nature of the treasures in their keeping.

We cannot end without an anecdote of Sloane which may not be known to all readers of *Nature*. In 1740 the composer Handel was taking tea with Sloane, who showed him his library. Handel placed his buttered muffin on the volume in his hand. The outraged silence of Sir Hans failed to appeal him with a sense of guilt. "To be sure," Handel admitted later, "it was a careless trick, but it did no monstrous mischief; yet it put the poor old bookworm terribly out of sorts. I offered my apologies but the old miser would not have done with it. Had it been a biscuit, it would not have mattered." And Handel went on to suggest that Sloane's displeasure was due to his parsimoniousness. "But muffin and butter. And I said to myself, 'Ach, mein Gott, that is the rub! It is the butter'; which, of course, it was, but not for the reason which Handel alleged. In those days butter was not rationed—except in libraries.

CHARLES SINGH

CHEMISTRY OF STYRENE

Styrene

Its Polymers, Copolymers and Derivatives. Edited by Ray H. Boundy, Raymond F. Boyer and Sylvia M. Stoecker. (American Chemical Society Monograph Series, No. 115.) Pp. xxii+1804. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1952.) 160s. net.

THIS impressive volume is the complete guide to the chemistry of styrene, its polymers, copolymers (excluding synthetic rubber) and their derivatives. The extensive study of styrene and its polymers has had a profound effect in high-polymer chemistry as a whole, and therefore the book is of very much wider interest than its title would imply. Since it deals with every aspect of the subject from the purely academic to highly specialized technology, it has to be a composite work from a number of pens. Its editors, R. H. Boundy, R. F. Boyer and S. M. Stoecker, who have themselves contributed extensively to the subject, have welded the separate articles into a coherent whole so effectively as to avoid undue overlap. With one or two exceptions the authors are members of the Dow Chemical Co., which pioneered much of the earlier work on styrene. The book, therefore, is authoritative, both on the academic and technological aspects. Besides being encyclopaedic in its contents, each contribution is a critical discussion of the topic under review. Furthermore, the wider implications of the discussion to other branches of polymer chemistry are not neglected, even though the main theme—styrene—is kept in mind. The compilation of a text of this magnitude, even with the best co-operation, occupies a considerable amount of time; but in spite of this difficulty each chapter is surprisingly up to date. In a series of appendixes to several of the chapters, more recent work up to 1951 is briefly reviewed and appropriate references quoted.

It is impossible in this brief review to do full justice to the wealth of material: it is only practicable to say something of the general arrangement and special features of the volume. The arrangement is strictly logical: the preparation and properties of styrene; polymerization methods; and the nature of the properties of the polymer, copolymers and derivatives of styrene. Although much of styrene goes into butadiene-styrene copolymers, synthetic rubber receives only a very limited treatment. Had this topic been discussed at all comprehensively, the book would have had to be doubled in size, and in any event synthetic rubber is best dealt with in a separate volume altogether.

The historical introductory chapter, when read with present-day insight, shows how much excellent knowledge there was about styrene before the intensive developments of the past fifteen years. The manufacture of styrene via ethylene and benzene is the only commercially important method, and this is dealt with in detail. Then follow particularly useful chapters thoroughly surveying the chemical and physical properties, analysis and handling of the monomer. The chapter on the polymerization of styrene is an essay in addition-polymerization in so far as the principles of the subject are concerned. Similarly, the chapter on the molecular weight of the polymer again outlines much that is of general interest in the treatment of the polymer as a high-polymer substance. No less complete are the chapters dealing with the mechanical, optical and electrical

properties of the polymer. Degradation of the polymer by all the usual agents is also treated separately. Logically, there follows a much shorter chapter concerned with the chemical modifications of the polymer. Next, the derivatives of styrene and α -methyl styrene are adequately considered, as well as the use of styrene in the production of resins of which it forms one component. The latter chapter is concerned much more with the practical affairs, and the theory is considered quite separately in a chapter on copolymerization. Since much of the work described in this volume has been done on the western side of the Atlantic, the editors have wisely introduced a chapter dealing with the German developments prior to, and during, the Second World War, which makes a very interesting comparison in the methods of approach used to solve these problems in two parts of the world.

Not content with covering the whole subject in this way, the editors arranged for a complete set of patents to form part of the book. This means that, if anything was omitted in the ordinary discussion, it is included in the considerable volume of references. A large section is devoted to the problems involved in the manipulation of the polymer as a plastic in all its variety of uses, the moulding and fabrication of sheet, and even of filaments. Although some of these processes are necessarily based on empirical knowledge, the authors of the chapters as far as possible have described fundamental principles, so that again these chapters have general interest for many other polymers with similar kinds of properties.

In short, this is a volume that anyone must possess who has to deal in any respect with styrene and its polymers. There is, too, a fund of knowledge of great interest to anyone dealing with synthetic polymers as a whole. It contains the story of an outstanding industrial achievement to a considerable extent spurred on, but not initiated, by war-time necessity.

H. W. MELVILLE

CENTRAL AMERICAN ORCHIDS

Orchids of Guatemala

By Oakes Ames and Donovan Stewart Correll. (Fieldiana: Botany. Vol. 28, No. 2.) Pp. iv+399-728. (Chicago: Chicago Natural History Museum, 1953.) 5 dollars, cloth bound; 4 dollars, paper bound.

CENTRAL AMERICA is well known as one of the richest two regions in the world for orchids, the other being New Guinea. Costa Rica, with an area about equal to that of Wales and an orchid flora consisting of about nine hundred species, is probably richer in orchids than any other comparable area; nevertheless, Guatemala, which contains more than five hundred species, may rightly lay claim to a very extensive orchid flora.

Accounts of the orchids of Costa Rica and Mexico have already been published, but in neither case in such detail nor in such an attractive manner as in the "Orchids of Guatemala". Indeed, Dr. Correll, following the death of his co-author, Prof. Ames, has produced a book which is a model of its kind, beautifully produced and printed.

Owing to the complexities of the floral structure of orchids, good illustrations are essential for their proper understanding, and these are provided on a scale seldom seen in an account of this kind. The whole book, of which this is the concluding part, contains

nearly two hundred delightful line-drawings, including illustrations of all the genera described and of many additional species. These supplement the excellent generic and specific descriptions and the workmanlike keys for the determination of the various groups. Dr. Correll, following the views of his mentor, Prof. Ames, takes a rather conservative view of species in the reviewer's opinion; but that is, of course, a matter on which no two specialists will entirely agree. Altogether, this is a book which no student of the orchids should be without and which, indeed, could well be studied with profit by workers on other groups of plants.

V. S. SUMMERHAYES

THE UNIVERSE AND ITS BEGINNING

The Creation of the Universe

By Prof. George Gamow. Pp. xii+147+12 plates. (New York: Viking Press; London: Macmillan and Co., Ltd., 1952.) 21s. net.

THE study of cosmogony occupies a peculiar position among scientific activities. From long experience it has become quite clear that, unless there are continuous and manifold checks applied to theoretical speculation, its relation to experience becomes extremely slender. The chance that pure theory, even when it has at its disposal the great volume of present-day knowledge of physics, could succeed in describing such ultimate phenomena as those concerned with the development of the universe from some elemental beginning is very small indeed. The observed data which bear on these questions are still wholly insufficient to provide a really adequate check on any hypothesis. On the other hand, it is obviously necessary in formulating any cosmological picture that it should be consistent with modern physical principles and knowledge as well as with the meagre observational data which bear directly or indirectly on the matter.

Despite the vanishingly small chance of hitting upon the actual way in which the past history of the universe has developed, the intellectual exercise involved in formulating a cosmogony consistent with the foregoing requirements is of absorbing interest. No more entertaining exponent of a scheme of this kind could be found than Prof. George Gamow, whose popularization of some of the more recondite principles of physics through the dreams of "Mr. Tompkins" are deservedly famous.

The account he gives of the development of the universe makes absorbing reading. The expert use of the most recent discoveries in nuclear physics also makes it very instructive as long as one retains due scepticism about the ultimate reality of the scheme proposed. Even the dullest of readers must be impressed by diagrams purporting to give, for example, the "Chemical changes in the universe during its first half-hour". The sheer impudence of it is breathtaking.

In the first part of the book Prof. Gamow discusses the case for a dynamic rather than static picture of the universe. He describes the evidence about the age of different parts of the universe. This evidence indicates that all parts are of about the same age—a few thousand million years—and he considers that this strongly supports the evolutionary picture.

The evolutionary picture which is proposed is based on the observational fact that the universe is

expanding. Assuming the rate of expansion to have been the same in the past, the present universe must have expanded from a state, which would have had the density of nuclear matter, about 1.7×10^6 years ago. It is this state, called the ylem, which is regarded as the primitive condition from which the universe is developed. The ylem is regarded as a nuclear gas at a temperature of many thousands of millions of degrees. In this gas protons, neutrons and electrons co-existed in a dynamical equilibrium. As the gas expanded, it cooled and nuclear synthesis began. The author claims that, by discussing the dynamics of the nuclear reactions involved, it is possible to understand the abundance distribution of the elements, which is significantly similar throughout the universe.

Having described the first hour of the embryonic universe, Prof. Gamow then considers the processes which led, through the course of a few hundred million years, to the structure of the present universe with its stars and galaxies. In the course of this he discusses many aspects of astrophysics, such as the sources of nuclear energy in the stars, which are quite well established and of great interest.

The whole book is written in a most pleasant style, and it presents a coherent argument throughout. For the professional physicist and astronomer it is well worth reading for the excellent way in which new ideas are presented and the outlook of modern physics employed. For the student or the layman it should make fascinating reading, as it is in no sense technical and has the largest possible horizon.

H. S. W. MASSEY

ELECTRON OPTICS: PURE AND APPLIED

Electron Optics

By Prof. O. Klemperer. (Cambridge Monographs on Physics.) Second edition. Pp. xiii+471. (Cambridge: At the University Press, 1953.) 50s. net.

IN describing this book one cannot help recalling the well-known lines about books written by Bacon in his "Of Studies": "Some books are to be tasted, others to be swallowed and some few to be chewed and digested". Bacon would no doubt have agreed that all three categories could have been accommodated in the one book under review here, for it caters for three separate types of reader—physicists working in fields other than electron optics, those engaged in electron optical design, and those actively engaged in this research field and pondering over its problems.

Before discussing how the book meets these needs, it is as well to trace its origin and purpose. The monograph on "Electron Optics" appeared as a Cambridge Physical Tract in 1939. At that time the subject as such had been recognized as a new and developing branch of 'electron physics' for about a decade, and its general basic principles had been formulated. These had been stated with conciseness and clarity in the first edition; so much so, in fact, that it formed an excellent introduction to the subject for all those engaged in research and development work involving the principles of operation and design of electron devices of many kinds. Since that time the importance of the subject has been widely recognized in both academic and industrial fields, and a considerable volume of work has appeared,

enlarging upon and extending the field of application. The extent of this development can be gauged by a comparison between the first and the present second edition, in which the book has expanded to approximately six times its original size and includes some five hundred references to original papers.

The task of co-ordinating so extensive a field is no easy one. It requires a great deal of selective judgment and critical ability on the part of an author, as well as an exceedingly wide acquaintance with fundamental work in borderline fields; these are necessary in order to present the subject with coherence and unity. These qualifications are happily to be found in Prof. Klemperer, who has himself contributed a large amount of important work in the subject of which he writes.

While it can generally be said that the pattern of the subject-matter has now become formalized, yet the author introduces and develops many topics in an original way; in many instances there is evidence of an individualistic outlook which is highly stimulating to those actively engaged in research. The great merit of the book is that, as stated earlier, it can be used profitably by all types of worker. The novice will find a clear description of all the basic properties of focusing fields—electrostatic and electromagnetic—as well as their defects, treated mainly from the experimental point of view. The initiated will welcome good discussions on the effects of space charge on round and flat beams and fields, as well as a separate chapter under the heading of "Emission Systems" which deals adequately with the important characteristics of 'electron guns'. The chapter on emission systems with line focus brings to the reader's notice the characteristics of recent developments on 'box' and 'double lipped' lenses and their application to the design of X-ray tubes, triode and beam power valves and photomultipliers; while that on 'deflecting fields' will be of special interest to television engineers because of the detailed treatment of inherent errors and their correction.

The experimental physicist engaged on problems of 'separation analysis' will find much useful information on cylindrical and spherical condenser focusing systems, as well as on the properties of magnetic sector fields, and mass and beta-ray spectrometers (their dispersion and resolving power).

The final chapter, on applications in industry and research, is in a sense a consummation of all that has gone before, for it gives an account of the various fields in applied physics enriched by the application of knowledge of principles established earlier. Here are to be found clear descriptions of such important devices as television pick-up tubes, scintillation counters, image converters, electron microscopes, electron accelerators, storage tubes, etc.

On the whole, the book is authoritative and shows a good balance by skilful blending of the old and new. It gives a just emphasis to those topics which are in process of development, indicates and assesses the importance of complicating factors in interpreting fundamental results and will have the effect of stimulating the more advanced worker in his researches. It also carries much useful information in the form of curves, for the designer of systems who requires them to have a certain 'quality'. It has a good index and copious references to original sources. The latter could be improved in the bibliography by giving the page number in place of the chapter.

L. JACOB

Organic Chemistry

The Chemistry of the Compounds of Carbon. By Prof. Lucius Junius Desha. Second edition. Pp. xvi+595. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 55s. 6d.

PROF. L. J. DESHA has written an introductory course for university students, including those not continuing the study of chemistry. His aim is not to make a review of the vast amount of factual matter, but rather to help students to acquire an understanding of fundamental principles so that they may look up facts with intelligence.

Accordingly, in place of the usual approach he selects topics which serve his purpose and arranges them in a sequence so that concepts and terminology are gradually introduced. Then, as each theoretical point, such as resonance or reaction mechanism, is met, Prof. Desha gives a clear, elementary and yet, for this stage, sufficiently full exposition of it. Again, in pursuance of his plan, aromatic compounds are presented to the reader in as early as the fifth of the twenty-seven chapters; thenceforward alkyl and aryl compounds are considered together. Petroleum and coal, as the chief modern sources of industrial products, fill the sixth chapter. Prof. Desha devotes three chapters to polyfunctional compounds, one to dyes and one to heterocyclic compounds. In Chapter 27, on organic chemistry and life, substances such as cortisone and penicillin are not merely mentioned but more than a page is given to each.

This is a brightly written book, effort-requiring yet socially and intellectually interesting. It is obviously the work of an experienced teacher. The new edition is thoroughly up to date and affords a sound introduction to organic chemistry for all kinds of students.

G. F.

Manures and Fertilisers

By Dr. A. M. Smith. (Nelson's Agriculture Series.) Pp. xii+276. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1952.) 15s. net.

THE student who takes up this book as a guide to the study of manures and fertilizers will find himself in good hands. Dr. A. M. Smith, of the Edinburgh and East of Scotland College of Agriculture, is a teacher and advisory worker of long experience who has many valuable points of contact with the fertilizer industry and has closely observed the changes in fertilizer policy operating during and after the War. So far as the chapter headings are concerned, the book follows conventional lines: it starts out with the general principles of plant nutrition, follows with a discussion of the various bulky and concentrated organic manures, and then turns to the common nutrients and trace elements. The treatment of these topics is exceedingly good.

Dr. Smith wastes no words; in the compass of some two hundred and sixty pages he has brought together an impressive amount of information that is reliable and up to date. Particularly useful sections deal with composts, sewage sludge and town refuse, while the section on poultry manure contains information not easily obtainable in compact form elsewhere. In dealing with the fertilizer materials, a note is provided on the natural reserves of raw materials, and the reader obtains a clear outline of the manufacturing processes without becoming bogged down in technical detail. Sidelights are thrown on the fertilizer salts used in other countries—a useful point since British materials are comparatively few. The chapter on trace elements is

well done and put in its proper perspective, and it is emphasized that the diagnosis and treatment of deficiencies is a specialist's job. The broad lines of fertilizer utilization on the various crops is the subject of a lengthy chapter.

Running through the book there is a streak of agricultural common sense which is not always apparent in publications of this kind.

Rockets, Missiles, and Space Travel

By Willy Ley. Pp. xii+436. (London: Chapman and Hall, Ltd., 1951.) 30s. net.

THIS is the second English edition of the author's book published in 1948 under the title "Rockets and Space Travel" (see *Nature*, 163, 820; 1949). The new edition has been very largely rewritten and amplified; the ground covered remains essentially the same, but the material has been rearranged. The most important addition is an account of recent American developments in rocketry carried out in New Mexico at the White Sands Proving Ground—a site established in February 1948 for the testing of long-range rockets. The first projectiles fired here were German V2's, which were later followed by American missiles of a similar character such as the 'Aerobee' and 'Viking' rockets. Military rocket research in Great Britain, which dates from 1934 and was well under way in 1937, is described more fully than in the first edition. It is unfortunate, but unavoidable, that official reticence should have created the impression that British achievements in this field have been of minor importance. There are several appendixes containing a varied assortment of numerical and factual information on all aspects of rocket development and navigation. Finally, the valuable bibliography has been considerably extended.

R. A. RANKIN

Statistical Tables for Biological, Agricultural and Medical Research

By Sir Ronald A. Fisher and Dr. Frank Yates. Fourth edition, revised and enlarged. Pp. xi+126. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 21s. net.

THIS standard work, first published in 1938, is indispensable for anyone seriously interested in statistics, and most such persons already possess one of the earlier editions and will want to know how much new matter now appears. The Roman numbering of the tables is retained with Arabic appendages for new tables. Since the first edition, Tables V, VIII, XI, XVII and XXIII have been improved, and ten new tables have been added. These deal with the significance of the difference between means when the variance cannot be pooled, with the fiducial limits in a binomial distribution, with bacterial counts estimated by dilution until there is none left, and with tests for periodic components. There are two new tables for geneticists, giving scores for linkage data from intercrosses, and segmental functions. There is also a table of the normal probability integral and two tables of random permutations.

The explanations and examples in the introduction are very valuable for beginners and generally adequate; but those dealing with Tables VIII 3 and XXIV might perhaps be amplified with advantage. The authors have done much not only for the professional statistician, but also for the weaker brethren, though they refuse to provide the simplified *t*-test based on ranges. It was clearly impossible to include everything.

J. H. GADDUM

ELECTRON MICROSCOPIC OBSERVATIONS ON BACTERIAL NUCLEI

By Dr. J. R. G. BRADFIELD
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WIDELY divergent views have been held regarding bacterial nuclei. Some investigators have denied their existence; others have gone to the opposite extreme and suggested that bacteria consist of naked nuclei. In fact, however, there has long been strong evidence (reviewed by Robinow, Bisset and Knay¹) for the existence in bacteria of bodies equivalent in many respects to the nuclei of animal and plant cells. Apart from the size problem, the chief difficulty in the demonstration of bacterial nuclei by the light microscope has been the existence in the cytoplasm of these organisms of abundant ribonucleic acid, which often stains strongly with 'nuclear' stains, thus masking the nucleus itself, or else creating the impression that nuclear material is uniformly distributed throughout the bacteria. When the ribonucleic acid is removed by dilute acid, or by ribonuclease², nuclei can often be demonstrated. As regards work with the electron microscope, progress has been hindered by at least three factors: (a) absence of specific staining methods; (b) doubts as to whether bacterial nuclei might be expected to appear dark or light in electron micrographs; (c) the considerable opacity of whole unstained bacteria (especially cocci) to electrons, in the normal current working-range of 50–100 kV.

Techniques

These obstacles have been to some extent overcome by two recent developments: (a) thin sectioning; (b) a modified Feulgen stain suitable for use with the electron microscope. The sections described here were cut on a modified Cambridge rocking microtome at a thickness of approximately 0.035 μ from bacteria fixed in most cases in buffered osmium tetroxide solutions and embedded in poly-*n*-butyl methacrylate³. In the normal Feulgen technique, mild acid hydrolysis produces from deoxyribonucleic acid an insoluble aldehyde, which re-colours Schiff's reagent and takes up the purple dye so produced. This dye cannot, however, be detected in the electron microscope. Hence, in the modified Feulgen technique, details of which will be published elsewhere, the aldehydes produced by acid hydrolysis of deoxyribonucleic acid are allowed to reduce ammoniacal silver hydroxide, thus depositing metallic silver, which can easily be detected in the electron microscope. A similar technique has already been employed by Bretschneider⁴, on the rather unrewarding heads of mammalian spermatozoa, the extremely dense Feulgen-positive contents of which still defy cytological analysis. Our procedure is rather simpler and based on experience in the use of ammoniacal silver for staining connective tissue. Our observations have so far been limited to two kinds of bacteria—the 'Oxford' staphylococcus from the National Collection of Type Cultures, and a paracolon bacillus (*Paracolobacterium* sp.) morphologically similar to, but slightly smaller than, *Escherichia coli*. In each case, organisms from old resting slopes were compared with actively growing organisms freshly suspended in a 'Difco' broth for four hours at 37° C.

Staphylococcus aureus

Intact staphylococci (Fig. 1) are extremely dense to 70 kV. electrons (even when formal-fixed and unshadowed) and little or no detail of their internal structure can be observed. In sections (Fig. 2), the actively growing coccus (average diameter 0.5 μ) shows a well-defined, spheroidal, central area (0.2–0.25 μ in diameter), which in osmium-fixed cells is of markedly lower electron-scattering power than the periphery. This clearer central area contains bodies remarkably similar in form and arrangement to chromosomes (Fig. 2) and nucleoli (Fig. 3), though it would be rash to identify them as such without much further study.

The modified Feulgen stain (Fig. 4) shows that most—probably all—the deoxyribonucleic acid is localized in these central bodies. The latter, therefore, have both the morphological and the chemical characteristics of animal and plant nuclei and may properly be called bacterial nuclei.

Several kinds of control are run for the modified Feulgen staining method, including the normal Feulgen control in which the preliminary acid hydrolysis is omitted. In general, such controls confirm the validity of the method, though further critical investigation along established lines⁵ is needed. One difficulty which we hope to overcome is the random precipitation of silver granules during staining, common to most ammoniacal silver techniques; this probably accounts for the small deposits around the extreme periphery of the bacterium (Fig. 4), which was stained whole before sectioning. (It would certainly be unjustifiable at present to regard them as evidence of peripherally situated deoxyribonucleic acid.)

Although the boundaries of the nucleus are quite distinct, we have as yet seen nothing which could clearly be identified as a nuclear membrane. In a dividing staphylococcus the nucleus elongates, becoming dumb-bell-shaped, and nips into two. The two daughter cells often remain associated for some time in the familiar 'diplococcal' stage, separated by a double cell-wall; but under our conditions of growth, four-cell aggregates do not occur. The relatively uniform distribution of chromatin throughout the dividing nucleus (Fig. 5) argues against the existence of true mitosis; but since it is by no means certain that there exists a full nuclear apparatus of chromosomes, nucleoli and nuclear membranes, it is premature to make detailed comparisons of division mechanisms.

Paracolon Bacillus

An actively growing paracolon bacillus, fixed in a buffered osmium tetroxide solution, possesses a large, irregular, ellipsoidal central region of low electron-scattering power (Figs. 6, 7). In a bacillus 2 μ long and 0.8 μ wide, this clearer central zone is about 1.5 μ long and 0.4 μ wide. The modified Feulgen stain (Fig. 8) shows that the deoxyribonucleic acid is localized in approximately the same region. This suggests that, as in the staphylococci, the central clearer region in the osmium-fixed organism is the nucleus.



(1) Whole staphylococcus, shadowed 30° to horizontal. (2-5) Sections of actively growing staphylococcus: (2) probably chromocomes in cell approaching division; (3) probably nucleolus; (4) modified Feulgen stain, the central cluster of silver granules, indicating that the nucleus is rich in deoxyribonucleic acid; (5) dividing nucleolus. (6) Longitudinal section, and (7) oblique transverse section, of actively growing paracolon bacilli. (8) Longitudinal section of old, resting bacillus. (9) Longitudinal section of old, resting bacillus. (8) and (10) Modified Feulgen stain showing (in whole bacilli) large nucleus in non-dividing cell (8) and smaller, more compact nuclei in two recently formed daughter cells (10). Magnification: each scale represents 0.5 μ .

The nucleus of the bacillus is much larger (relatively and absolutely) than that of the coccus, the nucleocytoplasmic ratio being about 1 : 2 for the paracolon bacillus and 1 : 10 for the staphylococcus. Like those of the cocci, the nuclei of the bacilli appear to contain chromatin threads and nucleoli; but detailed interpretation is complicated by the existence of fingers of cytoplasm protruding into the nuclei, the latter being much less distinct and compact than in the cocci. This irregular form is greatly accentuated in older, resting bacilli (Fig. 9), where the nuclei ramify through the cytoplasm like the giant branching nuclei in the silk glands or ovarian nurse cells of insects*. In these remarkable metazoan cells nuclear branching is associated with great cell volume and very active protein secretion; as they grow, their initially spherical, orthodox nuclei ramify throughout the cytoplasm—to some extent preserving the balance between nuclear surface and nuclear volume which is thought to be necessary for the nucleocytoplasmic interchanges involved in protein secretion. The small and inactive resting bacilli present exactly the reverse situation, and their branched nuclei arise by quite a different sequence of events. As the bacteria age there occurs what might almost be described as an 'atrophy' of the nucleus—the cytoplasm increasing in bulk and pinching the ellipsoidal nucleus of the young, actively growing bacterium into the shrunken, branching, aged form; the latter is, of course, smaller in volume than the young nucleus from which it has come—in contrast to the branched silk gland nuclei, the volume of which greatly exceeds that of the young nuclei from which they arise.

The reason for the uneven shrinkage of these bacterial nuclei is by no means settled; but it may be related to the fact that the nuclear membrane (if

such exists) is rather tenuous and difficult to distinguish, in marked contrast to the distinct, usually double, nuclear membranes, some 250 A. thick, observed in sections of many animal and plant cells. Only in dividing paracolon bacilli (Fig. 10) have we observed nuclei as compact, well defined and strongly Feulgen-positive as those of staphylococci.

Paracolon bacilli (like *Escherichia coli* and unlike staphylococci, Fig. 1) flatten sufficiently when mounted whole on electron-microscope specimen grids to allow considerable penetration by 50–100 kV. electrons. It has long been known that carefully fixed, whole bacilli often show irregular 'clearer centres' surrounded by a dense peripheral layer, and these clear areas have, without very convincing evidence, been called 'nucleoids'. Our observations confirm this view. Most of the clear areas observed in the intact flattened bacilli undoubtedly result from the large central vesicular nuclei. Indeed, there may well be a correlation between size, or nature, of nucleus and susceptibility to flattening, for the paracolon bacillus with its large vesicular nucleus, presumably containing abundant nuclear sap, is drastically flattened by surface tension forces during drying, even when it remains viable; whereas the staphylococcus, with a nucleus which is both relatively and absolutely much smaller than that of the bacillus, usually preserves its original (nearly spherical) shape very well during drying (Fig. 1). Of course, flattening is also much affected by the shape and nature of the cell wall.

Conclusion

Finally, it is noteworthy that, in contrast to their elaborate nuclei, the two species studied showed little conspicuous structural differentiation in their

cytoplasm. The latter was of fine, granular appearance, with occasional clusters of denser granules (150–400 Å. in diameter) in the polar regions of the bacilli, but no true mitochondria. Dividing cocci showed clear indications of the cytoplasmic vacuoles associated with ingrowing cell walls as demonstrated by Chapman and Hillier for *Bacillus cereus**. (See also Birch-Andersen, A., Maaløe, O., and Sjöstrand, F. S., *Biochim. Biophys. Acta*, 12, 395 (1953), whose paper on electron microscopy of sectioned bacteria appeared after the above was submitted for publication.)

Our main interest, however, has been in the nuclei, both because of their controversial status and because of their possible significance for studies on the evolution of the nuclear apparatus of higher organisms*. As regards the existence of bacterial nuclei, our observations confirm and extend the already strong evidence for the presence in bacteria of bodies which in two respects—chemistry and morphology—have much in common with the nuclei of animals and plants. There certainly are differences, for example, the degree of development of the nuclear membranes, but in the present state of knowledge the differences seem less conspicuous than the similarities.

The third major criterion of nuclear identity is behaviour at cell division. It is in this respect that bacterial nuclei appear to differ markedly from animal and plant nuclei, and from this point of view, therefore, they may be of outstanding interest for studies of nuclear evolution. It is perhaps a forlorn hope that the evolution of the protoplasmic organelles of animals and plants can ever be traced by study of modern micro-organisms. But at least it may be possible, without prejudicing any evolutionary issues,

to distinguish three main levels of 'nuclear' organization (excluding those small viruses which contain no deoxyribonucleic acid): (a) co-existence of deoxy- and ribonucleic acid without such structural adjuncts as chromosomes, nucleoli and well-defined nuclei, clearly distinguishable from cytoplasm—that is, the state of affairs which presumably exists in many small and medium-sized viruses; (b) localization of deoxyribonucleic acid and nuclear ribonucleic acid on special structures (chromosomes and nucleoli) within a moderately well-defined nucleus, which, however, divides amitotically—the condition characteristic of the bacteria here described and possibly of some large viruses; (c) the animal and plant condition, in which a fully differentiated nucleus divides by mitosis. However, great refinements of cytochemical techniques are needed before the wide variety of micro-organisms already recognized can be adequately surveyed and classified from this point of view.

I am indebted to Dr. R. M. Fry and Mr. R. C. Valentine for supplying me with the bacterial cultures used in this work.

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FISHERIES SURVEY OF THE MAURITIUS-SEYCHELLES AREA

AS the result of a recommendation in 1945 by Dr. J. F. G. Wheeler, a Colonial Development and Welfare Research Grant was made available for a survey of the fisheries resources of the Mauritius-Seychelles region of the Indian Ocean. The survey was carried out during the two years 1948–49 by Dr. Wheeler and Dr. F. D. Ommanney, and a comprehensive report has now been published*.

Between the Seychelles and Mauritius and forming with them an arc of a circle, the centre of which, six hundred miles away, is the north end of Madagascar, there is a chain of shallow banks which, except for a few isolated inlets, are never uncovered by any tide. The object of the survey was to assess the potential fish resources on and around those banks. The work was carried out mainly in a 70-ft. Scottish-type fishing vessel (M.F.R.V. 1), which made forty-two cruises providing approximately 286½ hours of fishing time. Ancillary observations were made in a schooner and certain other craft from the Seychelles and in small boats and pirogues at Mauritius.

It was found that the only fishable waters for demersal fish are on the banks themselves, as their edges fall away precipitously into great depths. Generally speaking, the best catches were made in

depths of 8–42 fathoms, and the hand-line proved to be the most effective fishing instrument. It was, in fact, demonstrated that catching-rates by the simple, inexpensive and fool-proof method of hand-lining equalled those of trawlers using complicated and expensive trawling gear in normal trawling areas.

There are some 3,300 sq. miles of fishable water within an overnight run from Mahé (Seychelles) and 7,500 sq. miles within three days 'steaming' distance at 8 knots. There is very much less fishable water within the same distance of Mauritius; but the extensive St. Brandon and Nazareth Banks are not more than four days 'steaming' distance away.

Pelagic fishes, strangely enough, were also found to be almost entirely restricted to waters inside the 100-fathom line over the banks and close inshore around the islands. These consisted of a wide range of species from giant sailfishes and swordfishes down to mackerels, anchovies, sardines and the like. No method of capturing any of these on a paying commercial scale was discovered, so pelagic fishing is considered to hold fewer prospects of profitable development than bottom fishing.

The demersal fish resources of the region, on the other hand, are regarded as exploitable and adequate for all foreseeable local needs, and there could well be an exportable surplus if an outlet on the East African mainland could be found and developed.

At present the fish stocks of both the Mauritius and Seychelles areas are exploited only in very small

* Colonial Office Fishery Publications, 1, No. 2: 1953. Report on the Mauritius-Seychelles Fisheries Survey, 1948–1949. Part 1. The Bottom Fishes of Economic Importance. By J. F. G. Wheeler. Part 2: The Pelagic Fishes and a Note on Tow Nettings. By F. D. Ommanney. Part 3: Note on Meteorology. By F. D. Ommanney. Part 4: General Considerations and Conclusions. By J. F. G. Wheeler. Pp. ii+145+5 plates. (London: H.M.S.O., 1953.) 40s. net.

measure over restricted areas near the inhabited islands. "In due time, says the report, development will come, "but the pattern of its realization is for others to decide". That, of course, must be so, for both Dr. Wheeler and Dr. Ommanney have now left the region; but it would have been helpful if, out of their knowledge and experience, they had offered more precise guidance to those whose lot some day it will be to do the developing. On one point, however, the report is quite clear and emphatic—any power-driven craft that may eventually be used for either fishing or further research on the grounds surveyed must be well-found, mechanically reliable, and carry really competent engineers. Wheeler and Ommanney's survey was beset with far too many avoidable difficulties and disappointments due to machinery failures. In the words of the report, their cruises went forward "under the urgency of impending break down". This applied not to one cruise only, but to all of them, for in the summarized log of the forty-two cruises there are no fewer than twenty-nine entries relating to mechanical failure of one kind or another, arising largely from unskilled attention.

The authors are very well aware that many of their conclusions are based on data that are regrettably 'thin'. In view of the inadequate facilities with which they were provided and the difficult conditions in which they worked, this is not surprising. What is remarkable is that so much was accomplished in spite of the difficulties. This was entirely due to the calibre of those in charge of the survey, and especially to the skill and competence of Skipper Davies, captain of M.F.R.V. 1, who was no less expert in the engine-room than in the wheelhouse; it was due to his skill that on every occasion of machinery failure emergency repairs were made and "the long drift to Africa never eventuated". The measure of the

hazards under which skipper and scientists worked (due to the ever-present threat of machinery breakdown) may be gauged from the fact that out of sight of land no other ship of any kind was seen during the entire commission and no contact was possible with either Seychelles or Mauritius on the effective range of their radio-telephone. In short, this survey by Wheeler and Ommanney was a truly heroic enterprise carried out in conditions that no one in an officially sponsored project of this kind should be asked or expected to contend with.

It will be the fervent hope of all those in any way connected with Colonial fisheries development and research that the Colonial Office and its advisers will pay particular heed to those sections of the Mauritius-Seychelles report that emphasize the importance of mechanical efficiency in sea-going vessels. The M.F.R.V. 1 was placed in the "willing but inexperienced hands of local mechanics", and the survey suffered accordingly. Fisheries development in Colonial territories must depend in large measure on power-driven craft. To maintain them in good and reliable working condition, where ordinary servicing arrangements are either poor or entirely lacking, demands engineering skill of the highest order. To attract engineers of the right calibre into such service requires that both salaries and working conditions be really attractive. Salaries but little higher than those obtainable in the United Kingdom or in other less-exacting posts will attract only low-grade talent with its attendant low efficiency. Such parsimony is entirely false economy. True economy lies in attracting and keeping staff of such quality that worth-while results will be obtained despite difficulties. Projects that flounder or founder through lack of talent in those entrusted with the work are wasteful in the extreme, no matter how tight-fistedly they are financed.

G. A. STEVEN

THE HOXNE INTERGLACIAL RECONSIDERED

By R. G. WEST

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THE Interglacial deposits at Hoxne, Suffolk, occupy a critical position in the Pleistocene stratigraphy of the British Isles. They directly overlie the Kimmeridgian Boulder Clay, contain an Acheulean industry and are covered by deposits of a later glaciation. The dating and the stratigraphy of the deposits are therefore of great importance. New evidence concerning both has recently been obtained by the application of pollen analytical methods and by an extensive programme of boring.

The deposits have been described in detail by Prestwich¹, Clement Reid² and Reid Moir^{3,4}. The accepted scheme of stratigraphy is based on the work of Clement Reid and Reid Moir. The succession described by Clement Reid and his climatic inferences from the plant remains are shown in Fig. 1 a. Later, Reid Moir described sections in the Oakley Park pit which showed that the Palaeolithic Loam rested directly on the Kimmeridgian Boulder Clay and was overlain by a deposit he believed to be glacial, and that it contained a temperate fauna and flora. He accepted Clement Reid's scheme of the stratigraphy and considered the Palaeolithic Loam or so-called "upper temperate brickearth" to be younger than

the beds B, C, D and E of Clement Reid, although it lay directly on the boulder clay. He was then able to complete the climatic succession to the top of the deposits. The resulting scheme of stratigraphy and climatic change, shown in Fig. 1 a, is a composite one, as the beds attributed to a position above the gravel B were described by both Clement Reid and Reid Moir from sections at the north and west faces of the Oakley Park pit, whereas the older beds B, C, D and E were described from the south-west corner of the Old Brickfield, on the opposite side of the Eye-Hoxne road, where the full presumed sequence could not be seen.

The pollen diagram obtained from an excavated section on the west face of the Oakley Park pit, at point 1 in Fig. 1 b, is exactly similar to the diagram obtained from the cores of a deep boring made at point 2, Fig. 1 b, in the south-west part of the Old Brickfield. The similarity of the pollen diagrams shows that Clement Reid's Palaeolithic Loam and bed E are of the same age. A large number of borings made in the area gave the stratigraphy shown in Fig. 1 b. Both the pollen analytical and stratigraphical evidence prove that there is only one

temperate horizon in the Inter-glacial deposit. The error made by Clement Reid and Reid Moir in differentiating the Palaeolithic Loam from the bed *E* was probably due to the difference in their appearance, for where bed *E* rises to near the surface, as it does in the north and west parts of the Oakley Park pit, it is weathered to the mottled colour characteristic of gley horizons of waterlogged soils.

The pollen diagrams from the beds *C*, *D* and *E* of Clement Reid show a succession from late-glacial conditions at the base of bed *E* to temperate conditions at a higher level. There is a marked and sudden change in the diagrams at the interface of beds *D* and *C* which probably represents an erosional unconformity, so that the diagrams do not cover the whole Interglacial period. The climatic inferences from the pollen analytical results are shown in Fig. 1*b*.

The thick and compacted lacustrine beds must represent a long period of deposition. The pollen diagram indicates that they probably belong to the Great Interglacial (Elster/Saale or Mindel/Riss Interglacial). The diagram is not of the type characteristic of the Last Interglacial in north-west Europe. In the presence of an *Abies* (silver fir) zone after the temperate deciduous forest phase it resembles the diagram from the Clacton Channel¹, but differs from that of the Cromer Forest Bed given by Woldstedt². The deposits also contain *Azolla filiculoides* Lam.³, a plant found in many deposits in north-west Europe which are dated to the Great Interglacial on geological evidence, but which has not yet been found in the Last Interglacial. There is no doubt that the basal boulder clay immediately precedes the lacustrine deposits, suggesting that this boulder clay probably belongs to a late part of the Elster Glaciation of northern Europe. The lithology and fabric of the overlying clayey sand and gravel indicate that they are in a primary position and were not deposited by solifluxion processes. The period of their deposition would then be the Saale.

The relation of the archaeology to the stratigraphy has been examined closely and there appears to be evidence for a single archaeological horizon in place in the temperate brown clay-mud (bed *E* of Clement Reid), at the level marked X in Fig. 1*b*. It is probable that the Acheulean industry is referable wholly or in part to this horizon, an attribution conforming with Baden-Powell's recent assessment of the material as 'Late Middle Acheulean'⁴.

A full account of the stratigraphy, palaeobotany and archaeological stratification is in preparation and

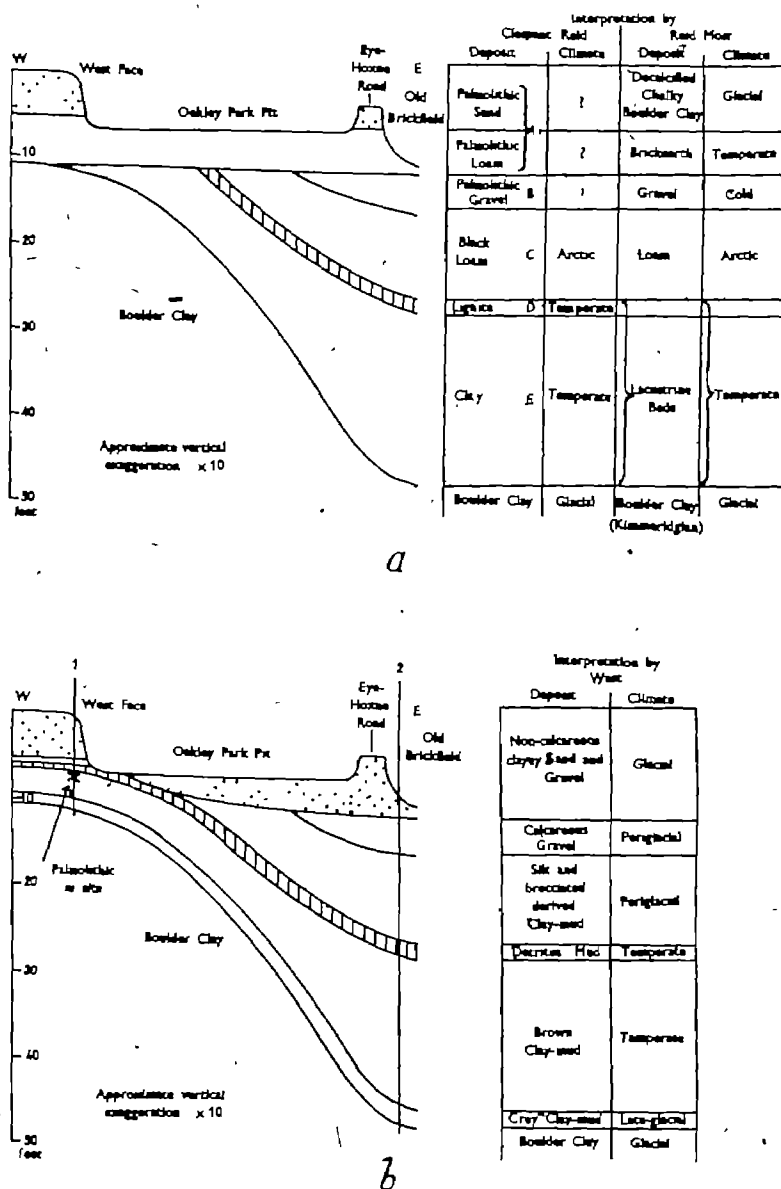


Fig. 1. Diagrammatic west-east sections through the western part of the Home deposits, showing the interpretation of the stratigraphical and climatic succession by Clement Reid and Reid Moir (a) and by West (b).

will be published elsewhere, together with some of the consequences for the revaluation of the East Anglian glacial sequence as a whole.

The work has been carried out at the Sub-department of Quaternary Research, Botany School, University of Cambridge, under the supervision of Dr. H. Godwin, during the tenure of a Nature Conservancy studentship. The deep boring was paid for by the Royal Society of London, and the Suffolk Naturalists' Society assisted in payment for certain of the excavations. We gratefully acknowledge the assistance given by both bodies.

¹ Prestwich, J., *Phil. Trans. Roy. Soc.*, 150, 304 (1860).

² Reid, C., *Rep. Brit. Assoc. for 1896* (Liverpool), 400.

³ Moir, J. Reid, *Proc. Prehist. Soc. E. Ang.*, 5, 137 (1928).

⁴ Moir, J. Reid, *Bull. Amer. Sch. Prehist. Res.*, No 11, 43 (1935).

⁵ Pike, K., and Godwin, H., *Quart. J. Geol. Soc. Lond.*, 108, 261 (1953).

⁶ Woldstedt, P., *Nature*, 163, 1003 (1950).

⁷ West, R. G., *New Phytol.*, 52, 267 (1953).

⁸ Baden-Powell, D. F. W., *Nature*, 163, 701 (1951).

OBITUARIES

Prof. Norman M. Comber

NORMAN MUNDERSON COMBER died at his home in Leeds on December 5, within three months of his retirement from the chair of agricultural chemistry and the office of head of the Department of Agriculture in the University. His retirement brought to a close a period of forty years service in the University of Leeds, during the last four and a half years of which, though beset by serious illness, he nevertheless continued with conspicuous courage to play a full part in the affairs of his Department. His death will be regretted by agricultural scientists and agricultural educationists everywhere, and not least by his many friends who had hoped that he might enjoy a well-earned period of retirement; and all will wish to extend their sympathy to his widow who, with a son and daughter, survives him.

Comber was a native of Brighton and graduated in 1909 after studying chemistry at the Royal College of Science, London. His first professional appointment was at the East Anglian Institute of Agriculture at Chelmsford, where his life-long interest in soil science was awakened and whence, in 1913, he came to the University of Leeds to join the staff of Prof. Charles Crowther, whom he succeeded in the chair of agricultural chemistry in 1924. In 1932, on the retirement of the late Prof. R. S. Seton, he became head of the Department of Agriculture and was responsible for its direction until his retirement, under the age limit, in September last.

Comber's researches, which have brought distinction to his Department and the University, were chiefly concerned with the aggregation of soil particles and were published in numerous papers in various scientific journals. His name will long be remembered in connexion with the 'Comber test' which he devised for the detection of sourness in soils. His research activities, however, were latterly increasingly limited by administrative responsibilities involved in the direction of a department which was concerned not only with intra-mural university work but also with extra-mural advisory and educational activities among farmers in the county of Yorkshire until, in 1946, these latter became the responsibility of the National Agricultural Advisory Service and the county councils, respectively. He was deeply interested in agricultural education, and his wide and varied experience led him to develop clear and strong views concerning the training of agriculturists and agricultural scientists. He was convinced that the optimum training for the agricultural scientist was one based upon pure science, a conviction which led in recent years to the establishment in the University of Leeds of postgraduate courses in agricultural sciences for pure science graduates. Nor was his interest restricted to education at the university-level, for he was responsible for the successful organization of day-continuation classes in agriculture for school-leavers in Yorkshire and did pioneer work in the establishment of the Yorkshire Federation of Young Farmers' Clubs.

During his forty years service in the University of Leeds, Comber played a full and active part in its affairs, as member of Court, Council and Senate, dean of the Faculty of Technology, chairman of the Board of Science and Technology, president of the Priestley Club and member of many committees. He had a profound interest in students and their welfare

which continued long after they had left the University. He was actively associated with many scientific and professional bodies. As secretary and later chairman of the Yorkshire Section of the Society of Chemical Industry, chairman of the Yorkshire Branch of the Rural Community Council, member of council and of the executive committee of the Rural Community Council, chairman and afterwards treasurer of the Agricultural Education Association, he gave ungrudgingly of his time and energy. He was a distinguished foundation member of the International Society of Soil Science, and had actively participated in its meetings not only in Great Britain but also in Italy, Hungary, the U.S.S.R. and the United States. The British Association for the Advancement of Science recognized his eminence as an agricultural scientist by electing him president of Section M in 1949, and shortly before his death the Agricultural Education Association, with which he had been actively associated since 1912, conferred honorary membership upon him in recognition of his outstanding services to agricultural education.

For many years Comber gave devoted service to the Baptist Church as lay preacher and deacon, and in 1938 the Baptist community in Yorkshire conferred upon him the highest honour they could bestow by electing him to the presidency of the Yorkshire Association of Baptist Churches.

All who studied under Comber or worked in close association with him will remember his genial personality, his acute, agile and critical mind, his meticulous attention to administrative detail and his mastery of both the spoken and written word; and they will recall his unquenchable sense of humour, which was evident even latterly in the face of a physical affliction which he bore uncomplainingly and with the greatest fortitude and courage.

J. S. WILLOOX

Prof. J. O. Wilhelm, O.B.E.

JOSEPH OSCAR WILHELM, director of the Research Council of Ontario, died in Toronto General Hospital on November 19, after a short illness. His death at the age of fifty-four has cut short a distinguished career.

Prof. Wilhelm was born in the village of Shakespeare, Ontario. Educated at the University of Saskatchewan and the University of Toronto, he lectured in the Physics Department of the latter university from 1927 until 1948. He served, on leave of absence in the Second World War, as technical assistant to the president of Research Enterprises, Ltd., with the National Research Council of Canada, with the R.C.A.F. as director of operational research, and with the federal Department of Reconstruction.

Following the War, he was secretary of the Ontario Research Commission during 1945-48, the work of which resulted in the establishment of the Research Council of Ontario. As director of the Council since 1948, his energy and ability were largely responsible for the organization of more than two hundred and fifty representatives of industry, government and universities in various research committees concerned with technical problems affecting Ontario's natural resources and the supply of scientists. In this work his deepest faith lay in new generations of students whose possibilities inspired his efforts.

In addition to many other affiliations, both in community organizations and professional groups, he was first vice-president of the Royal Canadian

Institute and chairman of the board of Knox Theological College, Toronto. He was well known to many scientists in Britain and the United States. A recognized authority on low-temperature physics, he was equally at home with men and ideas. His bent for organization sprang from his imaginative grasp of problems outside his own field, his fresh and stimulating spirit, and his capacity for friendship. Always willing to attempt the difficult, he was devoted to the public welfare. His early death was a shock to his many colleagues and friends, a great loss to Canada and the community in which he lived.

In 1927 Prof. Wilhelm married Nan Kathleen Munro of Saskatoon. He is survived by his widow, a son Donald who is at present in England, and a daughter Mildred still attending school.

W. J. MACKEY

Mrs. E. M. Reid

Mrs. E. M. REID, the noted palaeobotanist, died on September 28 in her ninety-third year. The daughter of John Copner Wynne Edwards, of Denbigh, she was educated at Westfield College, and taught mathematics at Cheltenham; she turned to geology and botany after her marriage to Clement Reid, of the Geological Survey, in 1897. Reid was a pioneer in the study of fossil fruits and seeds of the later geological formations, and Mrs. Reid threw herself wholeheartedly into this work, devising or improving techniques for extracting plant remains from peat, and bringing a methodical and highly critical intelligence to the study of the seeds and fruits so obtained. At that time it was by no means generally accepted that specific identifications were possible from isolated seeds and fruits, let alone from imperfect or fragmentary specimens which might have undergone alterations due to incipient fossilization. By a close study of the fruiting organs of living plants, however, the Reids proved conclusively that floral assemblages of the comparatively recent past could be reliably reconstructed from deposits which contained abundant fruits and seeds. Working backwards from Holocene and Pleistocene floras, their joint studies culminated in an extensive memoir on the "Pliocene Floras of the Dutch-Prussian Border" (1915). In 1916 Clement Reid died, only three years after retiring to Milford-on-Sea in Hampshire; his widow remained there for the rest of her life, and with great determination continued her palaeobotanical research. She described preglacial floras from Durham, with an important "Comparative Review of Pliocene Floras" (1920), and from then on was constantly consulted for determinations by botanists and geologists in various European countries.

After being joined by Miss M. E. J. Chandler, Mrs. Reid pressed her investigations farther back into the Tertiary, and in 1928 the British Museum (Natural History) published a volume by the two authors on the Bembridge (Oligocene) flora of the Isle of Wight, based on the a'Court Smith collection which had been acquired for the Geological Department of the Museum. Mrs. Reid was then asked to study, in conjunction with Miss Chandler, the extensive collection of pyritized fruits and seeds from the Eocene London Clay, which had been in the British Museum for more than a century. Seven years intensive work produced the "London Clay Flora" (1933), which at once took its place as a classic of Tertiary palaeobotany. In the introduction

to these two monographs, and particularly the second, Mrs. Reid analysed with great lucidity the phytogeographical, climatic and evolutionary significance of the European floral succession throughout the Tertiary, as revealed by studies of angiospermous fruits and seeds. Certainty of identification depended on morphological and anatomical structure, which in turn threw light on secular changes of character within genera and families; biogeographical alliances of genera represented in fossil floras showed an increasing correlation in past Tertiary periods with present floras of the Far East, until finally the Eocene of southern England proved to have a tropical flora related to that of the present Indo-Malayan region.

After the work on the London Clay, Mrs. Reid undertook no major commitments, though she published a number of short papers either alone or with Miss Chandler, who lived with her and with whom she continued to discuss further studies on Tertiary floras of southern England. The final results of this prolonged research are now being prepared for publication by the Trustees of the British Museum.

Mrs. Reid and her husband lived most frugally; her life was strictly ordered with a disciplined austerity; she was critical but charming, and could always find time to assist other inquirers. She was devoted to her church and other local affairs, and found solace in reading, particularly books of travel. Her scientific work was the outcome of steady perseverance combined with originality and an analytical mind.

W. N. EDWARDS

Dr. G. H. H. Tate

DR. GEORGE HENRY HAMILTON TATE, who died in Morristown, New Jersey, on Christmas Eve at the age of fifty-nine, was curator of mammals in the American Museum of Natural History, New York. Dr. Tate was born a British subject, on April 30, 1894, in London. He served in the Army during the First World War, and afterwards went to the United States, where, in 1921, he became a field assistant of the American Museum of Natural History. In 1927 he became an American citizen, and in the same year graduated as a bachelor of science of Columbia University, taking his master of arts degree in 1931. In the same year he was appointed assistant curator of South American mammals in the American Museum of Natural History, which post he held until 1942, when he was made associate curator of mammals, and later, in 1946, curator of mammals. In 1937 he was made a doctor of science in the University of Montreal. During the Second World War he served as chief of rubber explorations for the Defence Supplies Corporation at Washington.

During the course of his time at the American Museum, Dr. Tate went on forty-two collecting expeditions, to South America, New Guinea and Australia, as well as to West Africa. These expeditions, many of them carried out in association with Mr. Richard Archbold, led to an imposing series of monographs, those on the Chiroptera, Rodentia and Marsupialia being of particular importance.

Dr. Tate came fairly regularly to England, where his mother still lives, and his work brought him for weeks at a time to the British Museum (Natural History), where the staff of the Mammal Room were always glad to welcome him, together with his wife Eleanor who survives him.

T. C. S. MORRISON-SCOTT

NEWS and VIEWS

Applied Mathematics in King's College, London:
Prof. H. Bondi

THE vacancy in the professorship of applied mathematics at King's College, University of London, created by the departure of Prof. G. Temple to Oxford, has been filled by the appointment of Mr. H. Bondi, at present University lecturer in mathematics at Cambridge. Mr. Bondi entered Trinity College, Cambridge, in 1937 and was placed in the first class (Wrangler) of Part II of the Mathematical Tripos in 1939. His career was prevented from following the usual course by the outbreak of war, during which he engaged in important theoretical and experimental problems for the Admiralty. In 1943 he was elected to a research fellowship at Trinity College, and in 1952 to a staff fellowship.

Mr. Bondi's researches have been in a wide range of topics in mathematical physics, theoretical astronomy, and geophysics. Gifted with the degree of mathematical aptitude one associates with Cambridge and Trinity College, and possessed of a deep appreciation of the philosophical aspects of science, Mr. Bondi found suitable material for the application of his talents in the new ideas in astronomy that had been developing in recent years. His earliest papers were on such subjects as the theory of shock waves, of the mechanism of accretion, and the development of special methods for dealing with the refractory equations that govern stellar structure. In geophysics his work has been concerned with important hydrodynamical problems of the motion of the fluid core of the earth resulting from precession and the retardation of the earth's rotation. More recently, Mr. Bondi's name has been closely associated with the renewed activity in the field of cosmology, and in particular with the hypothesis of the continuous creation of matter, which is generally accepted by astronomers to be one of the most profoundly daring ideas yet introduced in astronomy. Mr. Bondi's wide reputation brings him into considerable demand as a lecturer, and twice during recent years he has been invited to the United States. In 1950 he visited Cornell University with a research appointment, and again in the autumn of 1953 he visited Harvard College Observatory to deliver lectures.

South Wales Laboratories of the British Iron and Steel Research Association:

Mr. D. Luther Phillips

MR. D. LUTHER PHILLIPS, who will retire in February under the age-limit from his post as head of the South Wales Laboratories, Sketty Hall, Swansea, of the British Iron and Steel Research Association, graduated in 1911 with honours in chemistry at the University College of Wales, Aberystwyth, and was later awarded an 1851 Exhibition industrial bursary at Baldwins Iron and Steel Works, Landore, Swansea. During the following years he became successively chief chemist and metallurgist, blast-furnace manager and (in 1928) works manager of the Landore works. In 1931 he was appointed senior research officer to the local steel and tinplate associations at the Metallurgy Department, University College, Swansea, and his work at Swansea on strain age-hardening culminated in a joint paper with Dr. C. A. Edwards and Mr. H. N. Jones on "The Influence of Some Special Elements on the Strain Age Hardening and Yield Point Characteristics of Low Carbon Steels",

which excited much attention, indicating a new and fruitful approach to this problem. In 1946 Mr. Phillips became head of the Laboratories at Sketty Hall, where he has done much to inspire the team working there on problems of coatings and steel surfaces.

Dr. J. Pearson

MR. PHILLIPS is to be succeeded by Dr. J. Pearson, at present head of the Chemistry Department of the British Iron and Steel Research Association. Dr. Pearson graduated in 1933 in the University of London, gaining his M.Sc. a year later for research in organic chemistry, and then joined the Research Department of Tube Investments, Ltd., to carry out work in connexion with the manufacture of steel tubes and allied products. During 1937-46 he was employed in the explosives branch of the Armament Research Department, Ministry of Supply, and obtained his doctorate in 1946 for research work on the polarography of organic compounds. In 1946 Dr. Pearson became head of the Chemistry Section of the Swansea Laboratories of the British Iron and Steel Research Association, where he was largely concerned with problems on the disposal of spent pickle liquor, and was appointed head of the Chemistry Department in February 1950.

Sir James Frazer, O.M., F.R.S. (1854-1941)

JANUARY 1 marked the centenary of the birth of Sir James George Frazer, in whose works a new science, the comparative study of primitive religions, was established. After graduating at Glasgow, Frazer became a scholar of Trinity College, Cambridge, thus beginning his long and happy residence there. He was afterwards elected to a fellowship at Trinity, which was thrice renewed and finally held for life, the total period being more than sixty years. Although his early work was on the classics, he soon turned towards the study of primitive religions, though his interest in the classics remained strong, as witness his five-volume work on "The Fasti of Ovid", published in 1929. In applying the comparative method to the study of religions, his aim was to regard them not as systems of truth or falsehood to be demonstrated or refuted, but as phenomena of consciousness to be examined like any other aspect of human nature. Many of his researches are embodied in "The Golden Bough". This great work developed slowly. As originally published in 1890, it was in two volumes. The second edition, which appeared in 1900, was in three volumes. Research continued, and finally, between 1911 and 1915, the great third edition in twelve volumes was produced. His friend Anatole France said of him: "Frazer nous a donné de l'homme la connaissance la plus vaste et la plus neuve. Il nous a fait entrer dans la pensée des barbares d'aujourd'hui et des temps lointains; il a substitué aux fables que l'homme imagine pour expliquer sa propre origine les premières données d'une science rigoureuse, qui n'existait pas avant lui". When he died in his eighty-eighth year, a life of long-sustained industry had ensured the permanent recording of the results of researches that have a profound significance for mankind.

The B.B.C. "Science Survey": Dr. Archie Clow

On February 4, Mr. Eric Simms is broadcasting in the B.B.C. Home Service on "Badgers: their Vocabulary and Language". This talk will be the 250th to be produced by Dr. Archie Clow, of

the British Broadcasting Corporation, in the series now well known as "Science Survey". This series has proved to be a remarkable achievement. Sir Edward Appleton said at the British Association meeting at Liverpool in 1953 that: "You have not really got to the bottom of the matter yourself if you cannot explain it to the man in the street"; Dr. Clow has always seemed to bear this in mind when selecting his speakers for Science Survey. Nevertheless, he has also always insisted 'on substance in these broadcasts and an absence of 'talking-down' to the listener. Scientific material, even that of immediate human or sociological or industrial importance, is sometimes very difficult material when being prepared for interpretation to the non-scientist, either by radio or through the newspaper press, yet it is possible to hold the interest of a listener or reader once his interest is captured at the initial stages. But this needs careful preparation and handling, and it seems that here Dr. Clow has revealed a genius for production. It is good, therefore, to have the opportunity on this 250th anniversary to congratulate Dr. Clow on his excellent work in scientific exposition and interpretation through the medium of the radio.

Science and Foreign Relations In the United States

WHILE the symposium of papers contributed to the September issue of the *Annals of the American Academy of Political and Social Science* gives a clear factual account of the part that the United States Congress plays in the foreign relations of the United States, it will disappoint those whose hopes had been raised by the appearance of the Berkener report on "Science and Foreign Policy". Following some account of the constitutional position of Congress and of the part it has played before and after 1900, the functions of Congress in foreign relations are explained and then the relations between legislature and executive. Nowhere, however, not even in the concluding discussion of the future of Congress in foreign relations, is any reference made to the recommendations of the Berkener report, and it would seem prudent to conclude that the likelihood of these recommendations being implemented is slight. The influence which science exerts on the foreign policy of the United States in the foreseeable future is likely to be negligible, at any rate until the public discussion of nuclear energy problems considered by Dr. J. B. Conant as desirable is also possible.

Insect Enemies of Western Forests of the United States

A FIELD manual by F. P. Keen on "Insect Enemies of Western Forests" has been issued as a revised edition by the United States Department of Agriculture (Misc. Pub. No. 273; pp. 280; Govt. Printing Office, Washington, D.C., 1952; 1 dollar). It is a very practical illustrated manual covering a wide range of forest insect pests, and written for the use of forest rangers, field-men and others responsible for the protection of the forest resources of the United States. The *raison d'être* is to bring together in summary form published bulletins, articles and records and also unpublished reports. The manual is restricted to insects found in forests west of the Great Plains, roughly the 100th meridian. In dealing with the control of the important bark beetles, of which some details of costs are given, the author correctly says: "At the best, remedial bark-beetle control is only a temporary expedient or a method

of suppressing outbreaks that have been brought about through some interruption or disturbance of the biological balance". The only permanent protection to forests is by the maintenance of the natural balance.

Fossil Water-Ferns

A NOTE in the *Transactions of the Suffolk Naturalists' Society* (8, Pt. 2) describes the discovery of two genera of water-ferns, *Azolla* and *Salvinia*, in interglacial deposits in Suffolk. Both these genera are new to the British Pleistocene flora, but have been found in interglacial deposits on the Continent. *Azolla* was found in the deposits at the classic site of Hoxne, and *Salvinia* in the interglacial deposit at Bobbitt's Hole, near Ipswich. Only the male and female spores of the plants have been found so far. The spores of the fossil *Azolla* are very similar to those of the modern *A. filiculoides* Lam., a species which was introduced into Britain towards the end of the nineteenth century. The species of fossil *Salvinia* has not yet been determined. (See also p. 187 of this issue.)

Potassium Absorption by Growing Root Cells

Using a technique, which is described, R. Brown and P. M. Cartwright (*J. Exp. Bot.*, 4, 11, 195; 1953) have shown that when thin serial sections of maize root, taken from the apex backwards, are immersed in 0.01 N solution of potassium chloride in water and in 2 per cent fructose, absorption of potassium by the distal or tip section, which consists almost entirely of meristematic cells, is abnormally low. This is attributed to the absence of a tonoplast surrounding a central vacuole in the cells of this region. The data for potassium absorption are presented in various ways, but when they are reduced to a unit cell basis they show that, per cell, absorption increases as expansion occurs in the root. This is ascribed to an increasing protein content. It is shown that during cell growth in the root, the cytoplasm differentiates in such a way that absorption per unit protein increases. When sugar is provided, the rate of absorption is always stimulated, though the effect of it on final concentration varies with the extent to which the tissue grows. Although when the root is sectioned the rate of absorption is lowest in the meristem, nevertheless this is the region of highest potassium concentration in the intact root. The mechanisms which may be involved in the different circumstances are discussed.

The Flamanville Granite In Normandy

IN 1894 Michel-Lévy published a memoir on the Flamanville Granite, long regarded as a classic, in which he recorded evidence indicating that the granite had been produced *in situ* from the pre-existing rocks. Dr. N. R. Martin has recently carried out a structural study of the mass (*Quart. J. Geol. Soc.*, 108, 311; 1953), using the techniques originated by the late Prof. Hans Cloos. Dr. Martin considers that the granite was emplaced as a diapir that forced its way through a belt of incompetent rocks—already folded on general east-west axes—which were readily buckled still further and thrust aside. The directions of the primary flow-planes of the granite minerals and of the foliation of the surrounding hornfelses are said to be consistent with the conception that the granite was forcefully intruded through a 'neck' below what is now the eastern side of the mass. As the resulting pluton was

continually fed with magma, it became inflated within a plastic cover, somewhat like an expanding balloon. In contradistinction to earlier views, it is concluded that, although metasomatism, feldspathization and assimilation of stoped blocks have undoubtedly occurred along the contacts, these processes are to be regarded as only incidental to the emplacement of the mass as magma. It is noteworthy that Dr. Martin states that the xenoliths detached by stoping "added to the volume of the magma" and that "their assimilation changed its composition". Thus no attempt is made to solve the space problem by stoping. On the other hand, the hypothesis of shouldering aside the country rocks has a serious weakness which is revealed by the 'balloon' analogy. Balloons frequently burst, and the Flamanville 'balloon' would surely have done so as its roof was torn apart by the underlying expansion. Once volcanic activity began, and that would probably be at an early stage, magmatic pressure would no longer be available for thrusting aside the walls. Speculation apart, however, Dr. Martin has made an important contribution by presenting genuine evidence that the mass is intrusive. Evidently the problem of emplacement is much more intractable than was previously supposed.

Personnel Officers In Industry

An interesting comment on the changing climate in industry is revealed in the annual report of the Institute of Personnel Management for 1952-53. The Institute is an association of men and women concerned with the personnel function of management. In 1922 the total membership amounted to 398; in 1937 this number had increased to 613. By 1942 this total had increased to 1,633 and, by 1952, had leaped to 3,806. The figures are ample evidence of the increased attention which is being paid to the human factor in industry. The report also directs special attention to developments in the retail trade and the continued emphasis on training, especially management training, as well as the extended contacts which have been built up in countries overseas.

National Research Council of Canada: Review for 1953

THE National Research Council of Canada's "Review 1953" (N.R.C. No. 3034; pp. 244+12 plates; Ottawa: Queen's Printer, 1953; 75 cents) gives, as is usual, more detailed and specific information on the work of the Council's laboratories during the year ended December 31, 1952, than is contained in the thirty-sixth annual report of the Council, and includes some later work. It also contains a directory of staff, as of July 1, 1953, arranged by divisions and sections of the Council, covering scientific staff from junior research officers upwards, and particulars of staff serving as representatives of the Council on external committees. Reports of the various committees include particulars of membership as well as, like the reports of several divisions, a list of publications during the year. Of the total staff of 1,955 on July 1, 1953, 535 were scientific, 675 technical, 472 general service and 289 maintenance.

First International Seaweed Symposium

THE proceedings of the First International Seaweed Symposium, held in Edinburgh during July 1952 (see *Nature*, 170, 478; 1952), has now been published (pp. 131; from the Institute of Seaweed Research, Inveresk, Midlothian, Scotland, 1953;

10s. 6d.). The lively contemporary interest in the biology and utilization of marine algae is indicated by the facts that this Symposium was attended by nearly two hundred people from twenty-one different countries, and that it is proposed to hold a second one in Norway in 1955. The fifty-three papers submitted, and abstracted in this report, deal with phyecology, algal chemistry, the commercial utilization of algae, harvesting technology and world resources. The main effects of the report are to indicate the wealth of biological and chemical problems awaiting investigation, to which the attention of students might well be directed, and the fact that substantial contributions are being made in many countries.

Scholarships for Study Abroad during 1954-55

THE British Council has published a booklet giving details of more than a hundred scholarships offered to British students by sixteen foreign countries for study abroad during the academic year 1954-55. The scholarships are intended mainly for graduates and undergraduates of universities in the United Kingdom, but some are also open to those with non-academic professional qualifications. The awards generally provide for free tuition and maintenance, and are tenable for periods varying from four to twelve months. The countries offering scholarships are Austria, Belgium, Brazil, Denmark, Finland, France, Germany, Iceland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and Yugoslavia. The closing date for receipt of applications varies for each country, the earliest date being March 8. Further particulars and application forms may be obtained by sending a stamped addressed foolscap envelope to any British Council office in the United Kingdom, or to the Controller, Education Division, British Council, 65 Davies Street, London, W.1.

N.Z. National Research Fellowships

THE Minister of Scientific and Industrial Research, New Zealand, has awarded the four National Research Fellowships to be taken up during 1954 as follows: R. W. Burling, a graduate of Victoria University College, who is at present doing research in geophysics at the Imperial College of Science and Technology, London, and will then undertake special research at the National Institute of Oceanography, London; R. A. Couper, a graduate of geology of Victoria University College, who will study palaeobotany at the Sedgwick Museum, University of Cambridge; P. A. Toynbee, a graduate in chemistry and diploma-holder in industrial chemistry of Canterbury University College, who will do research in Britain on the total gasification of sub-bituminous coals at the Birmingham Research Station of the Gas Research Board; H. P. Rothbaum, a graduate in chemistry of Victoria University College, who will study photochemistry at the University of Oxford. National Research Fellowships are offered annually to suitable applicants with postgraduate experience in scientific research to enable them to study in New Zealand or overseas institutions. Each Fellowship is worth £600 a year, with a marriage allowance of £100 a year, and grants of up to £50 for books, fees, etc., and up to £150 for travel are also paid. They are tenable for one year, with possible extension for a further year. The four present recipients, whose ages vary from twenty-seven to thirty-three years, are all members of the New Zealand Department of Scientific and Industrial Research.

Physicists In Britain during July

The Eighth General Assembly of the International Union of Pure and Applied Physics will be held in London during July 7-10 in the rooms of the Royal Society. The business meetings will be attended by delegates from the national adhering organizations of the International Union and by members of the Union's Commissions on Publications and Symbols, Units and Nomenclature; but, in order to profit by the fact that a number of distinguished foreign scientists will be in Britain for the occasion, a number of conferences on physical subjects have been arranged. Under the auspices of the International Union, two conferences will be held during July 13-17: one in Glasgow on experimental and theoretical nuclear physics, under the chairmanship of Prof. P. I. Dee, at which problems of nuclear structure and properties of mesons will be dealt with; and the other in Bristol on the physics of the solid state, under the chairmanship of Prof. N. F. Mott, at which defects in crystalline solids, and particularly their investigation by the use of microwaves and the relation between dislocations and other defects, will for the most part be considered. During the General Assembly of the Union, three lectures arranged by the Physical Society will be given at the Royal Institution by Profs. J. A. Wheeler, E. Amaldi and Charles Kittel on July 7 and 9 (at 4.30 p.m.) and July 12 (2.30 p.m.), respectively. In addition to these events, a small limited meeting on the mechanical properties of metals will be held during July 19-20 in the Department of Metallurgy of the University of Birmingham under the chairmanship of Prof. M. Cottrell, and the International Commission on Electron Microscopy will be holding a meeting in London during July 16-21.

Chemical Society: Anniversary Meetings In Manchester

The anniversary meetings of the Chemical Society will be held this year in the University of Manchester during March 31-April 2. The proceedings will commence with a symposium on "Dynamic Stereochemistry", arranged jointly with the Manchester Sections of the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Petroleum. It is hoped that the speakers will include Prof. C. K. Ingold, Prof. E. D. Hughes, Dr. P. B. D. de la Mare, Prof. E. Winstein (Los Angeles, California), Prof. V. Prelog (Zurich), Prof. D. H. R. Barton and Prof. K. Alder (Cologne). Further details of this symposium can be obtained from Dr. M. A. T. Rogers, Academic Relations Department, Imperial Chemical Industries, Ltd., Dyestuffs Division, Hexagon House, Blackley, Manchester 9. On the following day, April 1, there will be the annual meeting of local representatives of the Society, followed at 11.30 a.m. by the Liversidge Lecture, to be given by Prof. H. J. Emeléus, professor of inorganic chemistry in the University of Cambridge, who will speak on "Organometallic Compounds containing Fluorocarbon Radicals". On April 2 the Society will hold its annual general meeting, and then at 11 a.m. the president, Prof. C. K. Ingold, professor of chemistry in University College, London, will give the presidential address. The afternoons of April 1 and 2 will be devoted to visits to industrial organizations, and all three evenings will be taken up with social events. Further details can be obtained from the Society at Burlington House, London, W.1.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: A. G. Dalgleish (assistant secretary, Office of Member for Agriculture, Kenya), secretary for agriculture and natural resources (general), Kenya; R. F. A. L. Reed (senior agricultural officer, Nigeria), principal of schools, Agricultural Department, Western Region, Nigeria; E. Collins (chemist, Hong Kong), government chemist, Medical Department, Hong Kong; D. A. Frye (senior chemist, Federation of Malaya), chief chemist, Singapore; J. W. Du Preez (senior geologist, Geological Survey Department, Nigeria), assistant director, Geological Survey Department, Nigeria; R. Walls (assistant director, Geological Survey Department, Nigeria), deputy director, Geological Survey Department, Nigeria; C. F. F. Gayle (agricultural officer, Jamaica), senior soil conservation officer, Jamaica; J. H. Houghton (senior agricultural officer, Jamaica), chief agricultural officer (agronomy), Jamaica; E. R. H. Martin (assistant agricultural superintendent, Antigua), agricultural superintendent, Antigua; W. G. Stuart (senior agricultural officer, Jamaica), chief agricultural officer (development), Jamaica; A. D. Swan (meteorologist, Gold Coast), assistant director of observatory, Mauritius; A. K. Auckland, botanist (plant breeder), Tanganyika; T. E. Cobb, agricultural officer, Singapore; M. C. Cronin, J. B. Finney and P. R. MacCrimmon, agricultural officers, Nigeria; K. M. L. Matthews, agricultural officer, Uganda; W. F. Van der Byl Morkel, agricultural officer, Northern Rhodesia; H. Affleck, scientific officer, Federation of Malaya; R. F. Barnes, scientific officer (plant pathologist), Jamaica; P. S. Corbet, scientific officer, East Africa High Commission; C. C. Draper, medical research officer, grade 2, East Africa High Commission; M. J. Holden, scientific officer, Sierra Leone; A. W. Allen, soil scientist, Department of Agriculture, North Borneo; E. W. Fowler, chemist/assayer, Northern Rhodesia; D. A. Livingstone, economist/statistician, Kenya; J. Lucas, fisheries officer, East Africa High Commission; J. Stoneman, fisheries officer, Uganda; G. C. Vickers, veterinary officer, Jamaica; R. A. Wood, chemist, Department of Agriculture, Nyasaland.

The Night Sky In February

New moon occurs on Feb. 3d. 15h. 55m., U.T., and full moon on Feb. 17d. 19h. 17m. The following conjunctions with the moon take place: Feb. 4d. 21h., Mercury 4° S.; Feb. 12d. 05h., Jupiter 4° S.; Feb. 23d. 22h., Saturn 8° N.; Feb. 26d. 05h., Mars 4° N. In addition to these conjunctions with the moon, Mars is in conjunction with Antares on Feb. 25d. 0h., Mars being 5.4° N. Mercury is an evening star, setting at 17h. 45m. and 18h. 50m. at the beginning and middle of the month, respectively; but towards the end of the month it sets about twenty minutes after sunset, when it will be invisible. Venus, an evening star, sets too soon after the sun to be favourably seen. Mars, a morning star, rises about 2h. 15m. throughout the month. At the beginning of the month it lies a little south of γ Libræ, and at the end of the month a little north of α Scorpii (it has already been pointed out that it is in conjunction with this star on Feb. 25). Jupiter, visible throughout the night, sets at 4h. 20m., 3h. 30m. and 2h. 35m. on February 1, 14 and 28, respectively, and is a conspicuous object (stellar magnitude about -2) west of ζ Tauri. Saturn rises at 0h. 50m., 0h.

and 23h. 06m. on February 1, 14 and 28, respectively, and is visible in the morning hours (stellar magnitude about 0.6) north-west of α Libra. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: February 10d. 23h. 09.7m., 23 Taur. (D); Feb. 26d. 3h. 15.8m., α Scorp. (R). D and R refer to disappearance and reappearance, respectively.

Announcements

We regret to record the death, which occurred on January 21 at Christchurch, New Zealand, of Lady Rutherford, widow of Lord Rutherford of Nelson.

DR. J. SIKORSKI has been appointed lecturer in textile physics in the University of Leeds.

THE Dunlop Rubber Co. has made a grant of £2,000 a year, income tax paid, for the next seven years to the University of Birmingham, partly for general purposes but mainly to establish a Dunlop Fellowship for research work on the chemistry of high polymers, including natural and synthetic rubbers; provision for technical assistance; and the purchase of apparatus not formally available.

In 1947 the Wellcome Trust made a grant of £5,000 for whole-time research Fellowships in schools of pharmacy in Great Britain, and last year this was increased by a further £1,200 when five Fellowships were awarded and the value of each was raised from £350 to £400 a year. The Trust has now announced that it has set aside a further £10,000. The awarding committee, nominated by the Wellcome Trust and the Pharmaceutical Society of Great Britain, has discretion to award a senior research Fellowship at a somewhat higher rate, tenable for two years on an annual basis and renewable in exceptional circumstances for a third year. Fellows must be registered pharmaceutical chemists in Great Britain, or graduates in pharmacy of a British university.

THE Ministry of Agriculture and Fisheries is offering the following scholarships for rural workers, or the children of rural workers, of seventeen years of age or more: ten senior scholarships, tenable at universities or colleges, for degree or diploma courses in an agricultural subject or veterinary science; sixty junior scholarships and six extensions for existing holders, tenable at farm institutes, for one-year courses. Selection is by interview only. Further information and application forms (to be completed by March 31) can be obtained from the Secretary, Ministry of Agriculture and Fisheries, Room 313, 1 Cambridge Terrace, Regent's Park, London, N.W.1, or from education offices of County Councils.

TRINITY COLLEGE, Cambridge, is offering as in previous years a number of research studentships and Commonwealth exhibitions, which will be tenable from next October. The research studentships, which will normally be worth £375 a year, are open to graduates of universities other than Cambridge, who are not more than twenty-six years of age, with time spent in national service deductible from age, and who have not already been engaged on advanced study or research for more than two years. The exhibitions are for students from universities of the British Commonwealth, who intend to read for an honours degree, and are worth £40 a year. Applications, to be sent through the head of the candidate's university, must reach the Senior Tutor, Trinity College, Cambridge, not later than April 1 for studentships and May 1 for exhibitions.

THE international congress of chronometry organized by the Société Chronométrique de France, which was to have been held in Paris this spring (see *Nature*, November 21, 1953, p. 942), will now be held during October 1-5. Those wishing to read papers should communicate before June 1 with the president of the Society, Prof. R. Baillaud, Directeur de l'Observatoire National de Besançon, Doubs, from whom further information can be obtained.

THE Society for Endocrinology is arranging a symposium on "The Technique and Significance of Estrogen Determinations", to be held jointly with the Endocrinological Section of the Royal Society of Medicine at the latter's premises at 1 Wimpole Street, London, W.1, on February 24, commencing at 10 a.m. Those wishing to attend, who are not members of either Society, should write to Prof. N. F. MacLagan, Westminster Medical School, 17 Horseferry Road, London, S.W.1, for further details.

AN advanced course on information work, under the general title of "Organization and Development of Information Services", will be held by Aslib during February 25-28, the first three days being held in the premises of the Department of Scientific and Industrial Research at Charles House, 5-11 Regent Street, S.W.1, and the last day in the Aslib headquarters at 4 Palace Gate, Kensington, London, W.8. The course will be mainly a series of lectures and is planned to be of maximum benefit to information workers with from three to five years experience in the field. The fee for the course is five guineas for members of Aslib and seven guineas for non-members. Further information can be obtained from the Director, Aslib, 4 Palace Gate, London, W.8.

THE Ministry of Education is arranging a short course in metallurgy for teachers from technical colleges, to be held in the County Technical College, Wednesbury, during July 14-24. The course, which will be directed by Mr. R. W. Blount, H.M. inspector, assisted by Mr. S. G. Lawrence and other H.M. inspectors, will deal with modern metallographic techniques, mechanical and thermal treatment, modern methods of analysis, and radiographic techniques, and those participating will take any two of these sections. The work will be mainly practical; but there will be certain main lectures which all will attend. The course is residential, and a charge of £13 will be made for the full board and lodging. The tuition will be free. Application forms (Form 106 TSC), which must be returned by May 15, and further information can be obtained from local education authorities.

THE Turkish National Institute of Bibliography issues regularly a "Bibliography of Articles Appearing in Turkish Periodicals" which lists, in French and Turkish, articles published during the months covered by successive parts. The entries are numbered serially and arranged according to the Universal Decimal Classification (to two places only); within each section titles are arranged alphabetically by author. A list of periodicals covered is given, together with an author index. Part 4 covers August-September 1952, and includes 3,753 entries.

ERRATA. In the article entitled "Steric Effects in the Electronic Spectra of Organic Compounds" (*Nature*, January 16, p. 119, col. 1, line 13), for " $\theta_1 = 90^\circ$ " read " $\theta_1 = 90^\circ$ "; line 22, for " $\theta_1 \approx 0^\circ$ " read " $\theta_1 \approx 0^\circ$ ".

SHORTAGE OF GRADUATE TEACHERS OF SCIENCE

AT a conference called by the Federation of British Industries in London, on January 14, to discuss the shortage of science teachers in schools, the president, Sir Harry Pilkington, said that the national interest demands that enough science teachers of quality, for all types of educational institution, shall teach and train students in the next few years, so that our scientific and industrial leadership of the world over the next generation may resist challenges. Sir Harry declared that "industry will pay the price of leadership; industry will invest in research, in development, in progress, in expansion and in science. Industry will try to face its obligations towards encouraging a greater national investment in education of this type".

The demand and supply of science teachers was examined by Sir Charles Morris, vice-chancellor of the University of Leeds, who said that in the 1920's and 1930's a really good graduate took a long time to get a public school or good grammar school job as a schoolmaster. In addition, in the 1920's and 1930's, schoolmastering still attracted many able young men from the universities as a worth-while and gentlemanly life. For various reasons this seems to be no longer the case. There is to-day an effective economic demand for these men in research of all kinds, for general posts in industry and for university, college and school teaching.

The peak of this demand has not been seen either for research or for general industry. For university and school teachers the peak may well be reached between 1955 and 1960.

Of the good academic men with fine personal qualities—of whom industry, research and the universities and schools all must have some—there are not enough to go round. Outside the universities and schools they are needed for fundamental and industrial research. A knowledge of the world and human nature is needed to provide the necessary flair and imagination for effective industrial research and for general posts in industry.

Sir Charles questioned whether the undergraduate body of scientists could be increased still further; it is not so easy as might be supposed. Most people agree that our present degree standards are pitched at about the right place, and that a policy of greatly increased admissions should not be advocated if it would lead to large numbers falling by the wayside at the end of the first year. The answer to the shortage of graduate teachers in science is that "we must make sure we are using well all the scientists we have in research and in industry and that we must somehow again make schoolmastering attractive to the young man of spirit, imagination and ambition".

How is this to be done? More and more people are coming to think that the benefits of salary and other differentials must go to good men who actually do the teaching as opposed to good organizers and administrators in the schools.

Dr. A. W. Barton, headmaster of the City of London School, stated that the problem is as much one of quality as of quantity. There are probably two hundred science posts in grammar schools vacant to-day, while both the academic and teaching ability of new science teachers is lower than it was in 1938; 10 per cent of the science teachers are either non-graduates or graduates in arts subjects. In the past

ten years, 975 science teachers have left the schools for industry or administration. The shortage of science teachers is now beginning to be felt outside the schools. Two hundred places in university engineering departments were unfilled last October. A hospital medical school in London had 30 per cent of its places vacant at the same time. The science examiners for two of the largest examining boards reported that the majority of last year's General Certificate of Education candidates at Advanced Level passed by learning the work by heart instead of understanding it.

Dr. Barton suggested some possible remedies for this situation which is developing disastrously. A high-level conference representative of all the interests who both train and use scientists should be called to try to secure their fairer distribution. Governing bodies and headmasters should readily give facilities for research to able science teachers, who express a wish to undertake it, probably at a neighbouring university or technical college. Governing bodies should also seriously consider appointing more science teachers to headships of schools.

Science graduates should be deferred from national service if they go into school teaching. The Scientific Civil Service might second some of its scientific officers for, say, five years to the Ministry of Education for employment as school teachers. The universities could foster a rare combination of qualities by instituting general honours courses of three subjects, one of which should be an arts subject, such as English or history, and the others science subjects.

The industrial point of view was put by Dr. P. Dunsheath, chairman of the Federation of British Industries Education Committee, who said that the whole vast field of technology rests on the teaching of fundamental science; "anything which saps at the roots which lie in school science will inevitably have a disastrous effect on the growth of the plant which proliferates through industry".

There is considerable evidence, culminating in the latest report of the Advisory Council on Scientific Policy, to show that Great Britain is already behind some of its important industrial competitors in the application of science. To meet this situation we need not only a restoration of our former standards of science teaching but also a considerable advance on those standards. For the successful operation of an industrial concern there must be mutual respect between the staffs employed in the different sections covering research, development and production, which is fortified by the knowledge that all concerned possess a common understanding of the scientific principles involved.

Industry is more and more alive to the fact that the boy who leaves school at fifteen or sixteen and depends on subsequent part-time education suffers a disadvantage in his climb to the more responsible positions in industry. More boys who now leave at sixteen should remain at the grammar school up to the sixth form, and then take a formal part-time industry-based course in the science and practice of their technology. Such recruits will be very much hampered if they arrive without a good basis of mathematics and science on which to build their technology. Moreover, the very fact of strengthening the sixth form by keeping more boys in touch with

academic life may influence a larger proportion to choose teaching as a vocation.

The question of the balance between teaching in arts and in science is of considerable importance. On the assumption that a good brain may be employed with equal profit in both scientific and arts subjects, the obvious solution is to deflect some of the arts students to science.

Many difficulties will be side-tracked if suggestions for bringing pressure on schools to change their outlook overnight, on local education authorities to increase their wages bill, or on teachers' unions to accept larger differentials, are avoided. All these may be desirable but, from a practical common-sense point of view, should be avoided at present because of their potential for delay. The course least prone to cause delay through vested interests would seem to be not to press for a change in the attitude of the schools but to give opportunities at university entrance for change-over to science and engineering and to provide suitable pre-entry courses for the purpose.

Although the problem is a complex one and there are many possible solutions, industry should not be asked to curtail its intake. Graduates are not being employed wastefully. The urgent need is a larger pool from which both teachers and industrial recruits can be drawn.

NORTH OF ENGLAND EDUCATION CONFERENCE

AT the North of England Education Conference, held at Morecambe on January 4, Mr. J. Chuter Ede gave the presidential address in which, reviewing the first ten years of the Education Act 1944, he said that the outstanding disappointment has been the failure to eliminate the competitive examination at the age of eleven. Inadequate effect has also been given to the principles, propounded in the White Paper which preceded the Act, of directing ability into the field where it would find its best realization, and of facilitating free interchange of pupils from one type of education to another. Other disappointments to Mr. Ede were the failure of all but nineteen of the 146 local authorities in England and Wales to submit the development plans based on the Act, which they had originally been required to do in six months, and the failure to correct the bias against craftsmanship and to do more than offer better opportunities for technical education at the secondary stage.

Mr. Ede's main plea was for unity among teachers, parents and authorities; but he offered a welcome warning against straining after uniformity and confusing this with unity. His remarks on technical education were taken up to some extent in a discussion on Tuesday morning which followed addresses by Mr. C. H. Wilson, principal of University College, Leicester, and Dr. P. F. R. Venables, principal of the Royal Technical College, Salford, on the place of the university and the technical college in higher technological education. Mr. Wilson began with a brief review of changes since the Barlow Committee in 1946 recommended the doubling of the output of university graduates in science and technology. While this was virtually accomplished by 1947, all official statements continued to demand a greater output; but it is important to distinguish between graduates in all branches of technology and graduates

in fundamental science, and between short-term and long-term requirements for either. On a short-term view, while the supply of scientists is adequate so far as industry is concerned, it is inadequate for schools; but on a long-term view the supply of scientists seems to be reasonably adequate for some time ahead, though the best judges consider that further expansion in technology is still needed.

Discussing the adequacy of the present official policy, Mr. Wilson suggested that there may still be scope for the development of new departments of technology in the newer universities. In the long run the future of technology at the universities will be determined by four factors: the ability to forecast national requirements for the different kinds of technologist; the growth in industry of a much more generous view of the place of development research; the supply by schools of students wishing to take technological degrees; and the development at universities of a consensus of opinion more congenial to the expansion of technological studies. Mr. Wilson said that he recognizes the difficulties and dangers to the academic health of the universities if any one faculty becomes out of balance, and he insisted that the universities have to face the larger questions of the place that technological studies should take in the life of the universities as a whole and the environment in which such studies are best conducted: technology is not necessarily best taught in the environment of a strongly materialistic philosophy.

Dr. Venables's paper was concerned more particularly with the technical colleges and with its contribution to technological education, which he distinguished carefully from technical education. Compared with the technical colleges, the universities are a small and relatively homogeneous group, and he argued that, in considering the contribution which the technical colleges could make to the expansion of higher technological education, quality not quantity of work is the essential criterion. Technological education he defined as for those who "maintain, manage and maximise industry", with special emphasis on the last two. Of the 422 institutions in England and Wales dealing to a greater or lesser degree with technical education, we need be concerned with no more than those 220, the principals of which qualify for membership of the Association of Principals of Technical Institutions. Further, analysis of the work of these institutions, including the courses they offer, enrolments, recognition by professional bodies, their conduct of research and postgraduate facilities and regional requirements, have convinced Dr. Venables that it is essential to concentrate on some twelve to fifteen only of these institutions. Full university conditions could not possibly be created even for 44 institutions, he said, let alone 220.

Dr. Venables argued realistically that the exhortations and provisions of the Ministry of Education Circular No. 98 on Governance, No. 94 on Research, and No. 255 on Recognized Courses of Advanced Technology do not suffice for the further development of major technical colleges. The increased grant of 75 per cent and the recognition associated with it should on no account be made to an institution the local authority of which has not granted it a properly constituted established governing body with full powers within an approved annual financial estimate. If the local authorities will not or cannot shoulder the financial responsibility involved in the present

grant system, the increased grant, he suggested, should be paid direct to the college and the balance recouped from one or more of the local education authorities concerned. Under such a scheme it would be possible to plan long-term developments—Dr. Venables hinted here at the quinquennial principle—academic freedom could be secured for the staff and residential hostels would be more readily forthcoming. Such major institutions would not be able to provide for all aspects of technological work, and closer links would be desirable with the industrial research associations, which have their own part to play. Nevertheless, he thought that, by increased full-time and sandwich courses, by post-advanced or postgraduate courses and by research in co-operation with industry and the research associations, and further development of management education and training, the fifteen major technical colleges he visualized could make a greatly enlarged and vital contribution to advanced technology in Great Britain.

Dr. Venables's suggestion to concentrate on twelve or fifteen major institutions was supported by Mr. Wilson, and in the discussion Mr. D. J. Williams assured him of the whole-hearted support of the Association of Principals of Technical Institutions. Mr. Williams also advocated a separate major technical colleges committee. There was some general support, too, for the view that the present grants system is weighted in favour of the universities and the arts rather than the technical colleges and the sciences. In his address during the afternoon session on education and the administrative and financial structure of local government, Prof. S. E. Finer, University College of North Staffordshire, presented evidence that, in spite of the steady increase in educational expenditure, local authorities are still not spending nearly as much as they could and should on education; but his address did not bear very closely on the special issues raised by Dr. Venables. Prof. Finer was convinced that we need as strong a local government as can be achieved consistently with national standards, and that it is absolutely impracticable to centralize the administration of the schools. A recalculation of 1958 costs in terms of 1953 prices and school population shows that there has been virtually no increase in that part of the cost of each child's education which falls on local authorities. The real rate burden is very small and has become very much lower than before the War. The case for additional grant seems to be exaggerated, and he thought that local authorities should continue to bear the burden, subject to a reform of the education grant formula to make it more distributive, and based on a rating revaluation in 1956 with provision for a more elastic policy of exemptions and allowances in hard cases.

The sessions on January 6 were concerned with education in other countries, in which Prof. J. A. Lauwerys, University of London Institute of Education, dealt with the situation in the United States, and Dr. G. B. Jeffery, director of the University of London Institute of Education, with the position in the African Colonies. Prof. Lauwerys emphasized the diversity, the size and newness of the American system. There is urgent need, he said, for the development of educational practices which will foster the steadiness of character, power of critical thinking, independence of judgment and the vision that America's new role of leadership demands of her citizens. Of the comprehensive school, he suggested

that the British would do well to study with care American experience and then try to avoid repeating the mistakes made by others: one cannot say that because comprehensive schools work in the United States they would work in Britain. On the whole, he thought that the American system is better geared than the British to the imperative requirements of an industrial and technological education, and this aspect also deserves close study. Prof. Lauwerys was also very impressed by the enormous strides which have been made during the past twenty years in developing the professional aspects of the study of education.

Dr. Jeffery's address outlined the rapid progress made by the newly created Gold Coast Government, and in the subsequent discussion Mr. A. L. Binns described the very different conditions in East Africa. Dr. Jeffery maintained that the new development plans of the African ministers to-day, which he believed are fundamentally right in the practical circumstances, in spite of foreseeable dangers, are possible only because of the efforts of missions and the Colonial Education Service over many generations. In East Africa, Mr. Binns thought that the only hope lies in a great reinforcement of the few teams of British technicians and teachers who are already raising moral and material standards in small areas, so that the effort may be sustained long enough for the development of character in African leaders when moral stamina has been undermined by the dissolution of their traditional culture. In this connexion, Mr. T. H. Baldwin urged that educationists should make it possible for British teachers to take short-term appointments in the Colonies without jeopardizing their prospects at home. On January 7, in a paper on the place of the three 'R's' in the curriculum, Miss M. V. Daniel, principal of Hereford County Training College, urged that language, whether in reading or writing, should be envisaged as the means of communicating ideas, and mathematics as an interpretation of the physical world.

AGRICULTURAL CROPS: QUALITY VERSUS QUANTITY

A MEETING of considerable significance to British agriculture was held at Cambridge during December 15 and 16, when the National Institute of Agricultural Botany held its second Crop Conference with the theme of "Varieties in Relation to Crop Production". More than five hundred Fellows of the Institute, including farmers, seed merchants, maltsters, brewers, millers and agricultural scientists, attended to hear papers and discuss the topical problems posed by a quickly changing national and international position in relation to the production of primary agricultural products. The bulging wheat silos of North America and the threats of surpluses of coarse grain from the U.S.S.R. and other countries, coupled with a 'free market' for grain in Great Britain, acted as a stimulating, if sobering, background to the proceedings, and it was a matter of great interest to see how the conference quickly settled down to discuss the economics of quality versus quantity in the production of two of the three crops being considered—barley, sugar beet and wheat.

Dr. H. Hunter introduced the subject of the barley crop, which occupied most of the first day, and

immediately the conference was plunged into the intricacies of crop ecology, the physiology of development, the action of fertilizers, and the relationship between yield and malting quality. Very soon, also, the vital impact of plant breeding on crop production became apparent, and the conflict of interests between the farmer and the brewer, when considering the best varieties to grow, asserted itself. It appeared, however, that the newer hybrid varieties are helping to bridge the gap, and the farmer may not have to decide whether to grow for quality or quantity, because it is hoped these hybrids may combine both attributes.

This last point was emphasized by two of the three following papers on barley, in which Mr. O. S. Elliott described the behaviour of the new varieties and unnamed hybrids in the official N.I.A.B. trials, and Commander A. Cory-Wright put the maltsters' and brewers' points of view in considering varietal behaviour and the processors' requirements. Elliott's account traced the changes in barley varieties available in Britain since the advent of Spratt-Archer and Plumage-Archer, which are still generally the maltsters' and brewers' first choice, through the introduction of the Danish variety Abed Kenia, with its stronger straw, earlier ripening and potentially higher yielding capacity of poorer quality grain, to the greatly increased number of foreign varieties of similar type but often of no greater value. The problem has been to try to find a variety combining the desirable grain characters of the Archer barleys with the improved field characters of the Danish and Scandinavian varieties, and considerable progress has been made in this direction with the newest hybrids between varieties representing these two classes of barley. Thus the Danish variety Carlsberg and the English variety Proctor may be considered as real advances in combining higher yield with good malting quality; while other English hybrids are due for release next year.

Cory-Wright's contribution emphasized the change in the varietal position, the dangers of increasing the number of varieties, and the impossibility of making an overall general analysis to cover individual brewer's requirements in spite of a widely accepted interpretation of what is good malting barley. It appeared, however, that growers' and processors' views on varieties were by no means irreconcilable, though a word of warning was given concerning certain new varieties like Herta and Rika with pretensions to being malting barleys but with greater suitability for stock feed. Considerable interest was shown in Dr. A. Eden's paper on the utilization of barley for feeding, and the place of this cereal in the animal's ration, in relation to the composition of the grain.

A different aspect of quality was discussed by Mr. S. T. Skelton, on the afternoon of the first day, when he dealt with the quality of seed stocks. Skelton described the two main aspects of this quality as the appearance—size, colour, and freedom from damage, disease and impurities—and the authenticity and purity of strain or variety. The use of better methods of handling seed with improved machinery, seed testing and seed dressing are important methods of achieving better physical qualities, while the development of seed growers' associations and inspection schemes have done much for authenticity and purity. The speaker acknowledged the very valuable part played by the National Institute of Agricultural Botany in this matter of improved seed

quality, which has done much to lay proper emphasis on the importance of the highest standards in seed stocks and of the choice of the best varieties.

The sugar beet crop came in for very different treatment from the barley crop, as might be expected from the difference in the agricultural economy, the processing, and the utilization of the two crops. Mr. O. S. Rose, who dealt with the crop in general, speculated on the reasons for the much increased production per acre of sugar beet, and discussed ways in which varieties could be improved to produce what he described as the ideal sugar beet variety of the future. The list of characters was formidable: regularly-shaped single-germ seeds of high germination capacity, easily processed for sowing in a precision drill; strongly growing plants resistant to disease, bolting and chemical sprays; roots of heavy weight and high sugar percentage with high juice purity; and large tops with neat crowns easily removed by machine. Rose dealt with the practical significance of these characters to the sugar beet and beet sugar industry in Great Britain, making especial reference to the importance of obtaining some control for virus yellows, and he gave warning, from the reported experiences on the Continent, against being optimistic of the benefits of the use of monogerm seed and polyploid varieties. Mr. L. A. Willey elaborated on some of the more important varietal characters already mentioned in describing the results of the N.I.A.B. trials, and made special reference to the importance of bolting resistance (in which the varieties Cambridge K.N.B. and Klein AA are best), and to the difference in the financial returns resulting from growing the beet as opposed to the poorest varieties. These two papers emphasized that in sugar beet there is no conflict of interests between grower and processor when it comes to the choice of variety.

The final session of the conference, on the second morning, was devoted to quality in wheat, four papers being given on this topic. Mr. L. Hector Read, in dealing with the economic aspects of wheat quality, referred to the millers' attitude to milling quality, and the quality of the flour in relation to the use to which it is to be put. Read emphasized the vital importance to the miller of these grain characters, and he pleaded for a greater understanding by the farmer of the manufacturers' needs when choosing the most suitable varieties to grow, because grain quality is such a strongly expressed varietal character. A similar argument was put forward by Mr. Sebert Humphries, who dealt with flour, bread and biscuits from the millers' point of view. Humphries gave an unequivocal account of the requirements of the miller, the characteristics of foreign and native wheats, and varietal differences on the mill. He asked for there to be a purpose in English wheat production and a due regard for the prestige of English wheats, while he made a strong case for the millers' discrimination in buying particular varieties. Mr. E. N. Greer pressed home the very real differences between wheat varieties in the type of flour they produce, and he also gave an account of tests for milling and baking qualities in the laboratory.

These three papers emphasized strongly the conflict of views between the requirements of the farmer on one hand and those of the processor and manufacturer on the other, except in certain types of wheat. Thus, the most acceptable varieties for the miller, who has to consider the manufacturer who

will use the flour, are mostly the 'quality' native varieties like Yeoman and Holdfast, while the farmer prefers the higher-yielding, stronger-straw varieties like Cappelle Desprez and Bersee, and the French-type Hybrid 46 bred in Britain. Occasionally the apparently conflicting requirements are reconciled, as in the variety Atle, while, as in barley, hope for further reconciliation was expressed in the characteristics of new hybrids. Mr. D. G. Bullard put the farmers' point of view, and questioned, as did most farmers present, whether the millers would be prepared to pay an adequate premium for grain quality to compensate for the lower yield of the varieties of accepted quality that are available.

As in the case of barley and sugar beet, the wheat problem was left for the plant breeder to resolve as best he can. The conference brought out most clearly the demand and necessity for further improvement in the varieties of the three crops. The scientific problems posed by such continuous improvement are varied, and the work of improving, testing and sifting the plant material is the foundation of a progressive crop husbandry.

The chairman on the first day of the Conference was Mr. Roland Dudley, and on the second day Mr. Samuel Taylor. Dr. G. D. H. Bell summed up the proceedings on both days. G. D. H. BELL

ANALOGUE AND DIGITAL COMPUTERS

PROCEEDINGS OF THE WESTERN COMPUTER CONFERENCE

THE proceedings of the 1953 Western Computer Conference, held during February 4-6 at Los Angeles, California, under the joint sponsorship of the Institution of Radio Engineers, the American Institute of Electrical Engineers and the Association for Computing Machinery, has now been published* and contains the full text of the technical papers and of the panel discussion, together with résumés of the four addresses, presented at the Conference. The papers were concerned with the application of computers to the handling of business data and to aircraft design and with recent developments in analogue and digital computing equipment. The subject of the discussion was "An Evaluation of Analog and Digital Computers", and the panel of four experts, under the chairmanship of Prof. G. D. McCann, of the California Institute of Technology, consisted of Dr. J. L. Barnes, a mathematician and engineer, Mr. F. Steele, vice-president of Digital Control Systems and an engineer, Dr. L. Ridenour, formerly a nuclear physicist and now vice-president of the International Telemeter Corporation, and Dr. A. W. Vance, an electronics engineer of the Radio Corporation of America.

The addresses were delivered by Dr. Simon Ramo, of the Hughes Aircraft Company, Dr. R. D. Huntoon, of the National Bureau of Standards, Dr. Lee A. DuBridge, president of the California Institute of Technology, and Dr. J. E. Hobeon, director of the Stanford Research Institute. Dr. Ramo dealt with the impact of computer development on the training

and utilization of engineers. He maintained that the development of computers is work which may soon be engaging the greatest number of engineers and scientists; specially trained graduates with a knowledge of the physical sciences (with emphasis on electronics), the workings of the human brain and business and industrial procedures in addition to government and labour regulations are required, and industry must particularly avoid large programmes until such capable technical experts are available. Dr. Huntoon discussed the factors influencing the effective use of computers and coined the word "psycho-numerosis" to describe the problem of matching computing machines to the needs of research workers. He suggested that "electronic brains", like human brains, in the process of evolution must adapt themselves to their environment in order to survive and prosper.

The complex problem of scientific man-power was the subject of Dr. DuBridge's address. He outlined the salient factors which affect the supply and demand of scientists and engineers and suggested measures to remedy the present inadequate supply. Finally, Dr. Hobeon, in an address entitled "New Equations for Management", reviewed the various new factors which the complexity of industrial operations have introduced and indicated how the facts produced by applied research may be properly presented to and utilized by the managements of industrial concerns.

The eighteen technical papers were presented in four sessions. The first and second sessions were devoted to applications of computers to commercial and to aircraft design problems, respectively. The third and fourth sessions dealt with more specific technical problems in the design and use of particular sections or types of computers and included papers on the 'Nordseck' computer; the new laboratory for three-dimensional guided missile simulation devised by the Reeves Instrument Corporation, New York; an improved cathode-ray tube storage system; ferroelectrics as a memory element for digital computers; and the solution of partial differential equations by difference methods using the electronic differential analyser.

METEOROLOGICAL OFFICE

ANNUAL REPORT FOR 1952-53

THE Meteorological Office has the task of meeting the civil and Service (except naval) requirements of Great Britain for meteorological information of all kinds and of improving by research its ability to meet those needs. A feature of the report of its work during the year April 1, 1952-March 31, 1953*, is that during this period the organization for the provision of weather forecasts and other information was extended. One example of this was the application to the east coast as a whole after January 31, 1953, of the system of special warnings of meteorological situations known to be associated with coastal flooding, which had been applied successfully to the River Thames in London for many years. Experiments in the transmission by facsimile equipment to selected out-stations of charts drawn at the Central Forecast Office were begun with the view of im-

* Proceedings of the Western Computer Conference held by the Joint IRE-AIEE-ACM Computer Conference Committee, Los Angeles, California, February 4-6, 1953. Pp. 231. (New York: Institute of Radio Engineers, Inc., 1953) 3 50 dollars.

* Annual Report of the Director of the Meteorological Office for the Year April 1, 1952, to March 31, 1953. (M.O. 573.) Pp. 56. (London: H.M.S.O., 1953.) 2s. net.

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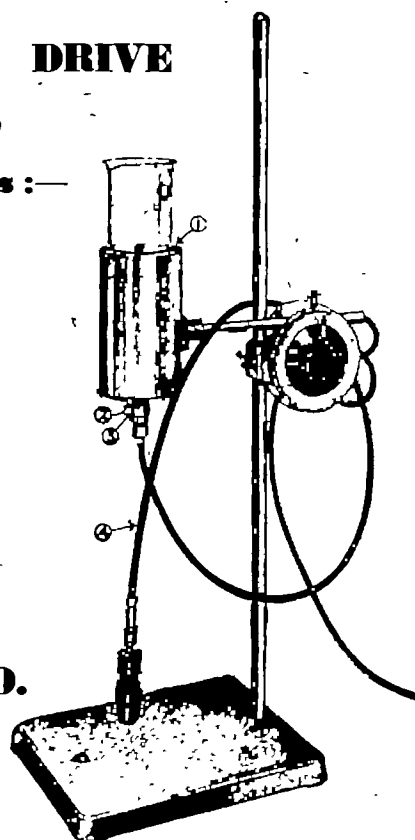


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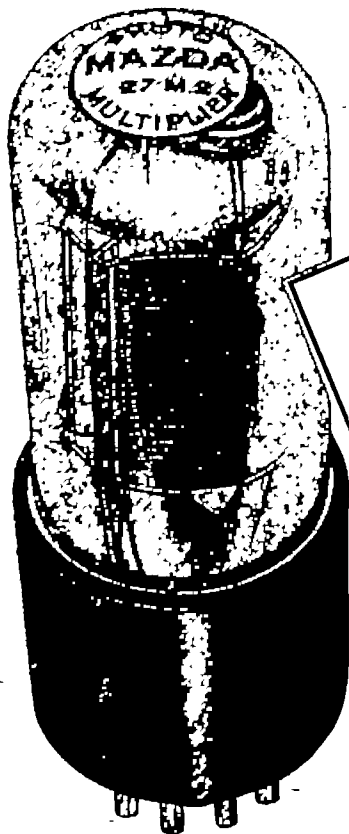
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proving the information and guidance available to outstation forecasters.

Inquiries for meteorological data and advice covered a wide range of industrial, agricultural and economic problems from the hatchability of hen's eggs to the effect of wind and low temperature on overhead cables and the irrigation of crops.

Much effort was again devoted to the study of meteorological data for high levels, and to methods of forecasting and making observations at these levels in connexion with the increasing demand for information for the navigation of jet aircraft. Charts of upper-air temperature and its variation were drawn on a world-wide scale, and a special study was begun of high-level winds over the tropics. Building began at the new radio-theodolite station at Crawley, Sussex, from which upper-air observations of hitherto unattained accuracy will be made.

In research into methods of forecasting, results of great theoretical interest were obtained from numerical calculations with electronic computing machines. In this work the machine is used to calculate the future pressure distribution from the present one by means of suitably modified forms of the equations of motion of the atmosphere. It is believed that this work is nearing the stage at which it will be of practical as well as theoretical value. Investigations were also made into the formation of anticyclones, and the detailed distribution of rainfall associated with depressions moving along selected tracks over and near the British Isles. Much research work was also carried out into questions of physical meteorology, such as the transfer of heat and humidity between the earth and the atmosphere (a subject of fundamental importance in pure meteorology as well as being very important in agriculture) and the formation of radiation fog. The Meteorological Research Flight carried out an extensive programme of research into problems of cloud physics and flying conditions.

Among the publications produced by the Office during the year may be mentioned a large "Climatological Atlas of the British Isles", "The Century of London Weather (1841/1949)", and a new edition of the "Observer's Handbook".

FOREST PRODUCTS RESEARCH LABORATORY, PRINCES RISBOROUGH REPORT FOR 1952

THE work of the Forest Products Research Laboratory, Princes Risborough, during the year 1952 is described in "Forest Products Research 1952", the report of the Forest Products Research Board and also of the director of the Laboratory, which was recently published*. During the year there has been little change in the nature and orientation of the Laboratory's work, but there has been a gratifying increase in research work both of the fundamental kind and also in technical projects of the broader sort which can lead to practical generalization.

The testing and evaluation of new tropical species, mainly from the British Colonies, continues to be the

* Department of Scientific and Industrial Research. Report of the Forest Products Research Board, with the Report of the Director of Forest Products for the year 1952. Pp. vi + 62 + 8 plates. (London: H.M.S.O., 1953.) 3s. net.

Laboratory's major project; but it is expected that the work which began last year on the assessment of home-grown soft-woods from various forest sites of the Forestry Commission will increase in proportion during the coming and successive years. These programmes of timber testing, together with advisory work, continue to occupy much of the available time of the staff. Seasoning and kiln-drying tests have been carried out on tropical hardwoods and home-grown soft-woods. Drying problems of interest are connected with the seasoning of birch for brush heads and the kiln-drying of East African pencil cedar (*Juniperus procera*) slats.

The "Lens Key to the Identification of Hardwoods" was published during the year, and a companion atlas of low-power photomicrographs is in course of preparation. With the help of the "Lens Key" and the atlas as a check, an investigator, even though he lacks access to a standard collection of timber, will be able to identify any of the four hundred timbers, both home-grown and exotic, dealt with in the "Key". The entomological branch of the Laboratory has been engaged on work connected with the excessive damage to imported tropical timbers by ambrosia beetles, the so-called pin-hole borers, so well known to the forest officer in India. The Laboratory has submitted to the Colonial Research Council a programme of research involving the appointment of three biologists as a West African Timber Insect Research Unit to be trained at the Laboratory; it is proposed that one should remain at the Laboratory, and the other two proceed to West Africa in due course, and this step has been approved by the Governments of Nigeria and the Gold Coast.

An unusual item which will interest many is a request by the Brewers' Society to have tests made to find a suitable substitute for oak for making beer barrels. History repeats itself: a century and a half ago the British Admiralty was searching the world for a substitute for oak for the construction of the wooden ships of the Navy, and it found teak; in the case of the beer barrel, the timber so far tested is, dahoma (*Piptadenia africana*), which has proved unsatisfactory. From beer the report goes to boats, tests having been undertaken as to the best way of making laminated bends for stern, hulls and frames. Work is also in progress on wood structure, timber mechanics and wood-working methods.

E. P. STEBBING

OVULATION AND PREGNANCY CORPORA LUTEA IN THE OVARIES OF THE HUMPBACK WHALE

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IT has been fairly well established that a permanent record of the number of ovulations remains in the ovaries of whales¹, and this record can be used in the study of the age of the whale. However, to date, apart from attempts by Peters² and van Lennep³ to distinguish between the two types of corpora lutea (more properly corpora albicantia), one resulting from ovulation without subsequent fertilization and



Fig. 1

Fig. 2

Fig. 1. Recently formed corpus luteum of pregnancy showing gel-filled central cavity. From ovary of whale carrying 4-m. embryo.

Fig. 2. Regressed corpus luteum of pregnancy showing connective tissue-filled central cavity.

one resulting from pregnancy, no further methods of distinction appear in the literature. Peters assumed the differences in colour and texture of the corpora albicantia to be indications of "ovulation only" and "pregnancy", and made an estimate of the number of ovulations per year in blue and fin whales. Colour appears to be a function of age of the corpora themselves, for the smaller corpora albicantia (apparently the older ones for the most part) are as a rule a much darker coloured orange-brown than those formed later.

Van Lennep made a histological examination of the corpora lutea of pregnancy and regressing corpora lutea in blue and fin whales, and suggested two possible means of distinguishing between old corpora lutea of pregnancy and old corpora lutea of ovulation: (1) arrangement of trabeculae of connective tissue strands, (2) size of corpora lutea. Corpora lutea of pregnancy possess more connective tissue than corpora lutea of ovulation, and this may be reflected in the sizes of the degenerating corpora lutea. However, the overlap of sizes of the two types of regressing corpora lutea constitutes a problem.

During the winter seasons of 1952 and 1953, at the land-based whaling station at Tangalooma, Moreton Island, Queensland, Australia, many observations on the corpora lutea in the ovaries of the humpback whale (*Megaptera nodosa*) were made, and very particular notice was taken of functional corpora lutea both of early and late pregnancy, and also of the ovaries from females in the early and late stages of lactation. The remarkable feature observed was that in 100 per cent. of these cases (thirty-seven individuals of all types) each corpus in question possessed a central cavity, variable in size from individual to individual, but always quite noticeable, this cavity being filled with a gel substance or fibrinous clot or a slight serous fluid. The same close attention was paid to all other corpora lutea in the ovaries, and it was found that a variable proportion of corpora lutea did not possess this characteristic cavity or core.

The close examination of the corpora lutea demands correct orientation and sections no larger than 8 mm. in width.

Dempsey and Wislocki⁴ give a description of the ovaries of the humpback whale, and in their summary conclude "that the large size of the whale's corpus luteum imposes certain anatomical peculiarities and physiological limitations on its vascular supply. The luteal arterioles and capillaries

are apparently unusually long. The functional restrictions in consequence of the lengthening of these vessels make it impossible for the luteal tissue ever to fill the entire cavity of the luteal body. These limitations result also in nearly complete avascularity of the centre of the corpus luteum associated with excessive fibrosis and hyalinization". Although van Lennep⁵ does not agree with this supposition, his statement on size comparisons does not necessarily invalidate it.

In all observations made at Tangalooma, the size of a 'corpus luteum of ovulation' did not exceed 88 mm., while those of late pregnancy and early lactation measured 100-130 mm.

All functional corpora lutea of early pregnancy possessed a central cavity filled with gel substance; but there were also cases where corpora lutea containing gel were not accompanied by an embryo in the very early stages of development in the uterus, although these could have been missed as the Fallopian tubes were not irrigated to discover whether fertilization had taken place. However, the early anatomical changes in the recently formed corpus are not quite clear as yet; but the sequence generally appears to be as follows for (a) 'ovulation' only, (b) 'pregnancy'.

(a) In 'ovulation only', the follicle ruptures and the egg passes to the Fallopian tube. The collapse of the follicle is followed by a rapid proliferation of the luteal cells with subsequent deposition of gel or hyaline substance (due to lag in growth of blood vessels behind the growth of luteal tissue). If pregnancy does not intervene, the gland attains a size of 80 mm., up to which size it appears possible for the blood vessels to supply sufficient blood without further hyaline degeneration into the centre, the luteal cells continuing to grow inward without much further increase in diameter of the corpus (up to a maximum of 88 mm. only), the further growth of luteal cells forcing the central gel to migrate into the deep crypts between the folds of luteal tissue. Apparently this gel, assisted by the adventitial cells



Fig. 3

Fig. 4

Fig. 3. Recently formed corpus luteum, considered to be a corpus luteum of 'ovulation only'. Note absence of a central cavity. No embryo in uterus.

Fig. 4. Regressed corpus luteum. Considered to be a corpus luteum of 'ovulation only'.

ally visible layers and corresponding to a network of cellulose chains making an angle of some 80° with each other. Complete understanding of such a structure is obviously impossible without an investigation of that of the *individual layers*—to decide whether even the finest layer has a structure similar to that of the whole wall. . . . The developmental study which we have made does just this, and it shows, moreover, how the first and the successive layers are laid down.

Preston and Astbury still seem to insist upon their original evidence for one set of cellulose lamellae in which the fibrils consist of a set of meridians. The arduous technique which leads to this conclusion was apparently carried out only upon one vesicle. Even so, the angles at which the chain directions crossed varied quite considerably at different parts of the wall and it seems that it would require more strict evidence to postulate a preferred direction as absolute as the system of meridians requires—evidence that should relate to more than one vesicle. Also, the evidence for the supposed poles seems not so convincing now as it might earlier have seemed to be. The areas in question gave an X-ray diagram which suggests disorder and random orientation, and this effect, through the whole thickness of the wall, might have arisen in other ways than the one suggested.

It is clear that the results of X-ray examination and of electron microscope studies of the same specimen should be compatible. It is granted that the X-ray method, and prominently so in the hands of Preston and Astbury, has yielded most valuable results. It is, however, still based on observations that have to be made over a relatively short length, which have to be extended over the wall surface as a whole, and it requires interpretations that are obviously complicated when dealing with a system composed of many successive layers each with its own fibrillar direction. Obviously what one does with the electron microscope is not to photograph one field but many such. The degree of integration which is obtained by the X-ray method, because it summarizes events over a given length, is obtained at least in part with the electron microscope by the taking of many pictures on many specimens and deciding from a very large number what is a typical condition and sequence of events. The electron microscope has, however, the great advantage that in each such field investigated the picture revealed has a degree of definition and precision that is not inherent in the X-ray method, which must average in each observation over a considerable area and many layers. Whereas in the electron microscope the several layers can be seen in sharp focus and the strand directions clearly discerned, the X-ray method only reveals this after interpretations that require to be made, and these, as is now evident, are subject to some uncertainty. For example, Preston and Astbury now suggest that the apparent prevalence of two layers in their work instead of three could be accounted for if one of these failed to show properly because two of them are more crystalline than the other. This is just the kind of problem that makes studies of this sort difficult by the X-ray method. The electron microscope seems to lead more directly to precision.

We can agree with Profs. Preston and Astbury that this, like any other problem of biology, requires further study. Our purpose here is to suggest that

understanding must comprehend how the structure of an organism grows and develops and, in achieving this, there is no substitute for the use in the investigation of the living material under such conditions that the changes that occur during growth can be observed. The application of this point of view to the problem of the *Valonia* wall has produced knowledge that did not arise from Preston's and Astbury's earlier work. This does not mean that the earlier results are to be rejected. It does mean, however, that knowledge grows by new observations, by the application of other techniques and by the different approaches that may be adopted by other investigators. It would be surprising and somewhat depressing, indeed, if sixteen years after the first major examination of the *Valonia* wall, made primarily upon a single vesicle, that this did not prove to be so.

In our view, the really challenging problems that these organisms still present are the following. What is the enzymatic machinery which permits the naked protoplasmic surface of the aplanospore so rapidly to build up cellulose in the manner that has now been described? What is the carbohydrate substrate that is utilized? What are the forces that control the first shift from randomly oriented fibrils to such strongly oriented parallel directions? Having once achieved order in the first direction, what induces the organism to lay down its fibrils in the successive directions which seem to be required? Even though there may be room for some difference of opinion concerning the minutiae of the structure of the mature wall, these great problems still present their challenge and the way seems now open for them to be attacked.

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- ¹ Steward, F. C., and Mühlethaler, K., *Ann. Bot.*, N.S., 17, 295 (1953).
² Preston, B. D., and Astbury, W. T., *Proc. Roy. Soc., B*, 133, 76 (1937).

ZONE ELECTROPHORESIS OF
MUSCLE EXTRACTS SEPARATED
OF PHOSPHORUS
CATIONS
PERCENTAGE

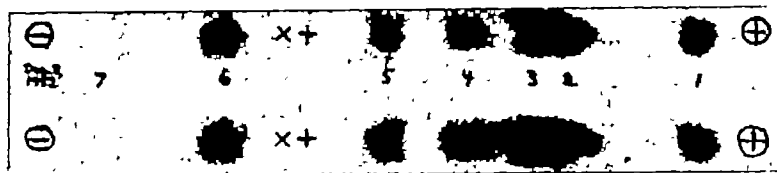


Fig. 1. Detection of rabbit muscle constituents by ultra-violet fluorescence after electro-phoretic separation on filter paper.

0.7 μ l. (upper half) and 1.0 μ l. (lower half) of neutralized muscle extract deposited at $\pm$. Spots marked $\times$ are starting points corrected for electro-osmosis. 165 min. electrophoresis at 25° C. and 10 V./cm. in sodium succinate buffer - sodium chloride of pH 5.6 and μ 0.45

1, phosphocreatine (as creatinine); 2 and 3, positions assigned to adenosine tri- and diphosphate, respectively; 4, adenosine monophosphate; 5, oxidized diphosphopyridine nucleotide; 6, creatine (as creatinine); 7, ascorbic acid and carnitine. Distance between centres of spots 1 and 5 corresponds to 90 mm.

Photograph taken with two 'Mineralight' lamps (2 hr. exposure) and two 'Philora' lamps (5 min. exposure), all approximately 40 cm. from the filter paper. $F = 23$; Ilford Rapid Panchromatic plate, shielded from ultra-violet rays by Wratten G filter and 15-mm. mirror glass plate

The usual procedure in the present experiments was briefly as follows: Cold perchloric acid extracts of fresh skeletal and cardiac muscle were neutralized and concentrated to a volume corresponding to 40 gm. muscle per ml. For electrophoresis, 0.1-2 μ l. was placed on or near the centre axis of an 8-cm. wide sheet of Munktell 20 filter paper; up to 250 μ l. was used per 100 c.c. of Whatman cellulose powder saturated with buffer medium and packed tightly into an elongated 'Perspex' frame. The electrophoreses were carried out at potential gradients of 10 volts per cm. (filter paper) or about 3½ volts per cm. (cellulose powder) in the apparatus and with the precautions described by Kunkel and Tiselius¹, the filter paper being held tightly between two silicone-treated glass plates. The current ranged from 2 to 50 m.amp. Cooling and temperature control, when desired, were achieved by letting the lower of the two glass plates surrounding the filter paper rest on a large metal block, partly immersed in a water-bath of the proper temperature and by covering the upper glass plate with a metal trough filled with water of the same temperature. The duration of the electrophoresis runs on filter paper was ½-3 hr.; the cellulose powder experiments were run over-night. At the end of the runs the paper sheets, serving as supporting medium, and strips of paper pressed briefly against the surface of the cellulose powder packs, were dried in an air-stream at room temperature and inspected in ultra-violet light of around 254 m μ .

(Mineralight lamps, V. Products, Inc.). This revealed the fluorescent spots and their positions. The fluorescent spots were then photographed with two 'Philora' lamps at 254 m μ .

of skeletal muscle is furnished by the photograph reproduced in Fig. 1. This experiment was carried out at an estimated temperature of 25° C. in 0.175 *M* succinate buffer of pH 5.6, brought to ionic strength 0.45, by addition of sodium chloride. As can be seen from the photograph, satisfactory resolution of several of the ions studied was achieved. It was important at the pH employed and at the relatively high ionic strength and the resulting high current (28-30 m.amp.) to prevent heating in the paper in order to avoid decomposition of the highly acid-labile phosphocreatine. As is to be expected,

this compound moves toward the anode at a high speed (spot 1 in the photograph). In addition to showing up as a dark spot in ultra-violet light, it could be revealed on the heated filter paper as creatinine by spraying with alkaline picrate², and as phosphate by treatment with acid molybdate reagent and hydrogen sulphide³. Further identification and quantitative analysis were afforded, following elution from the paper and treatment intended to convert phosphocreatine into creatinine, by the characteristic ultra-violet absorption curves and maxima of the latter compound⁴. Quantitative determination as the phosphate was not feasible because of insufficient separation at the pH's employed from free orthophosphate. The paper-chromatographic behaviour⁵ of the eluate from the area occupied by spot 1 on the unheated paper served as a further check on the identity of the eluted substance with phosphocreatine.

The spots at positions 2, 3 and 4 in Fig. 1 have been assigned to adenosine triphosphate, adenosine diphosphate, and adenosine monophosphate, respectively, on the basis of evidence provided by the ultra-violet absorption spectra of the eluates, by tests for acid-labile phosphate groups, and by comparison with authentic samples with respect to speed of migration in the electric field at various hydrogen-ion concentrations. Due mainly to the choice of a not very favourable pH and to the large amount of adenosine triphosphate present, this compound did not separate from the diphosphate in the experiment shown. As has been reported by other authors^{6,10}, separation of the adenosine phosphates by electrophoresis is best undertaken at pH 3.7-4. Hypoxanthine derivatives were not seen in significant quantities in extracts of fresh skeletal and cardiac muscle, but were found to prevail in cardiac muscle excised ½-1 hr. after death of the animal (calf). Similar observations were made during analyses of extracts of brain and of the conductive tissue of the heart. The acid-extractable nucleotide content of the latter tissue was found only about one-fourth that of ventricular

the substance responsible for spot 5 in Fig. 1. It was identified as oxidized diphosphopyridine nucleotide. A small amount of this substance was prepared from the corresponding zone in the cellulose powder extract isolated exhibited an absorption maximum in ultra-violet at 260 m μ . Electro-

an anion having about the size of a dinucleotide and carrying an average net charge not higher than unity. Its speed of migration toward the anode in this pH range was therefore compared with that of authentic diphosphopyridine nucleotide, and was found to be the same. Like the latter compound, the zone 5 substance was split by standing in 0.5 *N* sodium hydroxide for 15 hr. at 37° C. chiefly into adenosine-5-phosphate and a moiety which, judging from its electrophoretic properties, is probably nicotinamide mononucleotide. Contrary to what might be expected from the report of Schlenk, von Euler and co-workers¹¹, nicotinamide and its riboside are not major products of this alkali treatment. Appearance of an absorption maximum at 340 mμ on reduction with sodium hydrosulphite^{12,13} of the material eluted from zone 5 left little doubt as to the presence of diphosphopyridine nucleotide. Significant amounts of other substances containing nitrogen, ribose, or phosphate were not present in the eluate. In unfractionated perchloric acid extracts of calf heart muscle that has been contracting partly anaerobically for about one minute, oxidized diphosphopyridine nucleotide accounts, at pH 2, for 5-8 per cent of the absorption at 260 mμ, which is the absorption maximum of adenine and nicotinamide. In fresh rabbit skeletal muscle the corresponding percentage is lower.

Spot 6 in Fig. 1 was found to be due to creatinine formed from creatine by heating the filter paper, as evidenced by positive colour reactions on spraying the unheated and heated papers with α-naphthol-diacetyl¹⁴ and alkaline picrate¹⁵ reagents, respectively. The eluate from the unheated paper behaved like a solution of authentic creatine with respect to *R_F* values¹⁶ and ultra-violet absorption^{17,18}, both before and after treatment designed to transform creatine into creatinine. Another test for creatinine given by spot 6 and also by spot 1, after electrophoresis in 0.05 *M* potassium phosphate buffer of pH 5.9, was the appearance of a yellowish-green fluorescence following application of butyric acid at high temperatures¹⁹. For some unknown reason, creatine, present in and added to the muscle extracts migrated with a greater velocity towards the cathode than creatine applied separately, which at pH 5.6 is almost stationary.

Anserine and carnosine were identified as the components of fluorescent spot 7. The fluorescent material moved in the electric field with the same velocity as the authentic peptides. Carnosine was revealed on the paper as an intense red stain after spraying with alkaline diazobenzenesulphonate²⁰, while spraying with ninhydrin followed by heating produced a green coloration²¹. The eluate from the spot gave the same *R_F* values on the paper chromatogram as the authentic peptides^{19,22}, and yielded an ultra-violet absorption curve characteristic of imidazole compounds^{21,23}. (Using a Hilger 'Uvispek' photoelectric spectrophotometer we find the absorption maximum of L(+)-carnosine to lie at a somewhat lower wave-length than was reported by de Gouveia *et al.*²³, namely, at 212 mμ ($\epsilon = 6,600$), both at pH 3 and 11.) Because carnosine and anserine differ only slightly with respect to size, shape and ionization (see ref. 23), electrophoresis offers little chance for separating these compounds from each other. However, it makes possible their rapid separation from the bulk of the other muscle constituents.

The unmarked spots in Fig. 1 have not yet been identified. The bright fluorescent spot situated close behind phosphocreatine gave a positive reaction with the aniline hydrogen phthalate reagent²⁴, which suggests that the rapidly moving anion may be a phosphorylated sugar. Spraying of the filter paper with ninhydrin revealed, in addition to carnosine and anserine, a number of other ninhydrin-positive compounds present in appreciable amounts. Two of these, for which the heart of new-born animals is a good source, appear to be phosphorylated. This phase of the present work is not yet completed.

In some experiments, such as that represented in Fig. 1, requirements for determination of mobilities on paper were, in the main, fulfilled. Thus, evaporation of water from the liquid medium was held at a minimum, electro-osmosis was estimated, and other factors tending to disturb migration in the electric field, particularly adsorption of the ions under study on the paper, were taken into consideration. Making allowance for the electro-osmotic flow and for a 15-25 per cent retardation in the movement of the nucleotides, due to adsorption, and applying the correction factor of Kunkel and Tiselius¹ for non-linearity of the path of ionic migration through Munktell 20 filter paper, the following mobilities of some of the ions studied are obtained, at pH 5.6, ionic strength 0.45 and 25° C.: phosphocreatine, -20.6×10^{-8} ; carnosine, 8.8×10^{-8} ; oxidized diphosphopyridine nucleotide, -6.4×10^{-8} ; adenosine monophosphate, -11.5×10^{-8} ; and adenosine triphosphate, -17.7×10^{-8} cm.² volt⁻¹ sec.⁻¹. Mobility values for adenosine mono- and triphosphates calculated from filter paper experiments undertaken at ionic strength 0.1 and 0° C. were found to agree quite well with values¹⁹ obtained under these conditions in free electrophoresis.

This work was undertaken during tenure of a Life Insurance Medical Research Fellowship. I wish to express my sincere thanks to Prof. A. Tiselius and to Dr. O. Snellman for their hospitality and interest. I am also indebted to Mr. S. Jersted for performing the electrophoresis runs in packed cellulose powder, to Prof. H. M. Kalckar for a sample of diphosphopyridine nucleotide, to Dr. A. Deutsch for a sample of anserine nitrate, and to Dr. M. Ottesen for a sample of carnosine. [Aug. 25.]

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LETTERS TO THE EDITORS

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Internal Structure in Virus Particles

PREVIOUS electron microscopic studies of chick embryo chorioallantoic membranes infected with herpes simplex virus have revealed that the development of virus in susceptible (ectodermal) cells apparently begins in the nucleus and is completed in the cytoplasm¹. In the nucleus, the smallest particles considered to be virus measured 40–60 mμ in diameter and the largest did not exceed 130 mμ in diameter. Larger particles, some having a maximum linear dimension of 250 mμ, were seen in the cytoplasm or in extracellular locations. These observations were made on thin sections of tissue from which the methyl methacrylate had been dissolved by amyl acetate.

More recently, particles thought to be transected herpes simplex virus have been seen in ultra-thin sections of infected chorioallantoic membrane from which the embedding substance was not removed. Within the nuclei of cells the virus appeared to consist of a central, spherical body (40–60 mμ in diameter) of varying density, often surrounded by a single membrane (70–130 mμ in diameter), as illustrated in Fig. 1. Within the cytoplasm the particles were generally larger than 130 mμ in diameter and usually possessed a double membrane, as illustrated in Fig. 2. The membranes were separated from each other and from the central body by zones of lesser density. It thus seems reasonable to infer that herpes simplex virus has a definitive inner structure which may be related to its cycle of development within the cell. In this connexion, attention may be directed to the hypothesis of viral structure advanced by Pollard from purely theoretical considerations². The observations reported here tend to support his concept of a central body and an inner zone or membrane in the mature or complete viral particle.

This work was supported by grants from the Lillia Babbitt Hyde Foundation and the Lederle Laboratories Division, American Cyanamid Company.

Since submitting the above communication, which deals only with the virus of herpes simplex, an internal structure has been observed in both vaccinia and influenza virus. In vaccinia virus a body strikingly similar to a cell nucleus may be seen; the structure of influenza virus more closely resembles that of herpes simplex virus. These observations are being extended.

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A Method for the Rapid Differentiation of Certain Non-pathogenic, Asporogenous Bacilli

It is the experience of most microbiologists that the differentiation of the non-pathogenic, asporogenous, non-pigmented rods is of considerable difficulty. These bacilli form an appreciable part of the air-soil-water microflora and, in materials from marine environments, such as fish, in which our interests are focused, they comprise 60–80 per cent of the total number of species isolated¹. The main difficulty is that, by the usual tests, most of these micro-organisms appear to be biochemically inert, and the classification, based on a series of negative characters, is not very determinative. The types of organism we have in mind are usually classified among the Pseudomonadaceae, Achromobacteriaceae and Bacteriaceae of Bergey² and Prévot³. In Bergey, the Pseudomonadaceae comprises, among others, the genera *Pseudomonas*, *Vibrio* and *Spirilla*, and the Achromobacteriaceae the genera *Achromobacter* and *Flavobacterium*. In Prévot, however, the *Vibrios* are removed from the Pseudomonadaceae and form a genus of the Spirillales, while the *Achromobacter* and *Flavobacterium* become genera of the Pseudomonadaceae. Comparison with a recent Russian determinative system⁴ shows even wider divergences, the Achromobacteriaceae disappearing altogether, being grouped as *Bacterium* spp. under the Bacteriaceae.

A good example of the present difficulties is the differentiation between the *Pseudomonas* and *Vibrio* spp. According to Bergey, the former are more or less straight rods, usually forming a diffusible pigment, whereas the latter are usually curved rods with no pigment production. In practice, this

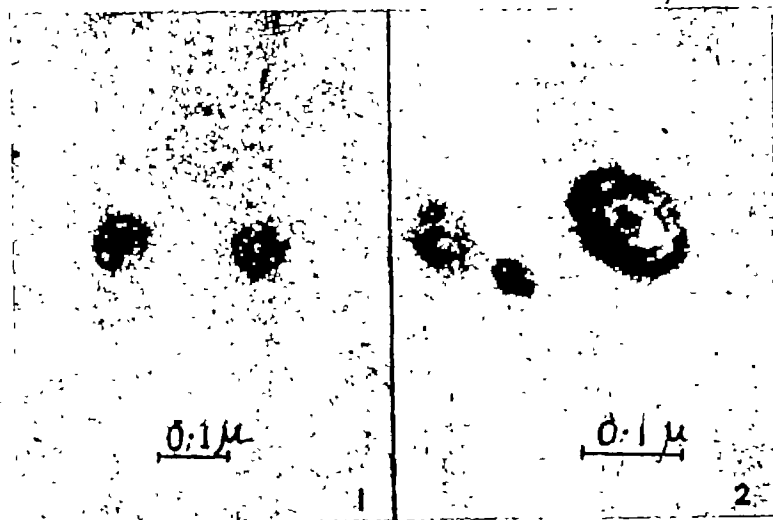
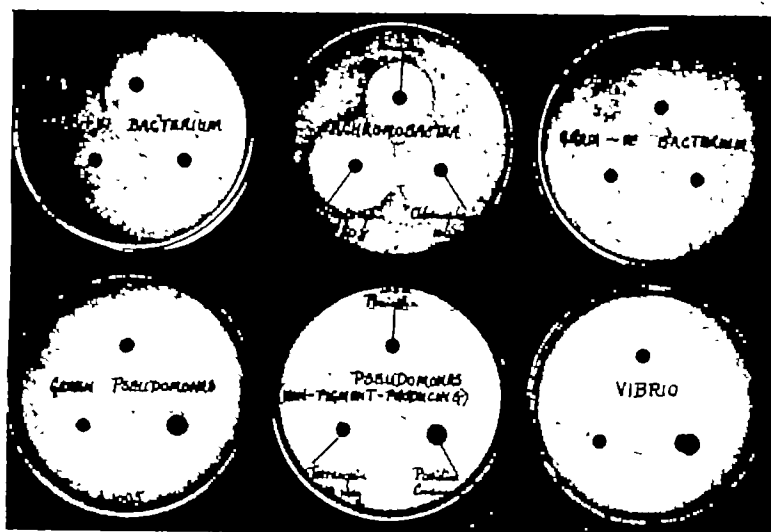


Fig. 1. Two intranuclear particles showing central bodies and single outer membranes.
Fig. 2. A particle in the cytoplasm showing the characteristic double outer membrane and central body.



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Table 1

Type of organism	Inhibiting agent		
	Penicillin (2-5 I.U.)	Terramycin (10 γ)	Vibriostatic compound 0/125* (sat. aqueous sol.)
Pigment-producing <i>Pseudomonas</i>	—†	—	—
Non-pigment-producing <i>Pseudomonas</i>	—	+	—
<i>Vibrios</i>	—	+	+

* 2-4 Diamino 6-7 di-isopropyl pteridine. † —, insensitive; +, sensitive.

Table 2

Type of organism	Inhibiting agent			Motility
	Penicillin (3-5 I.U.)	Streptomycin (80 γ)	Chloramphenicol (100 γ)	
<i>Pseudomonadaceae</i>	—*	+	+ or ++	+ve (polar flagella)
<i>Achromobacteriaceae</i>	+	++	++	Mainly —ve or +ve (peritrichous flagella)
<i>Bacteriaceae</i> { Gram +ve	+	+	+	+ve (peritrichous flagella)
Gram —ve	—	+	+	or —ve

* —, insensitive; +, sensitive; ++, very markedly sensitive.

differentiation is not easy, and is never satisfactory, more particularly as many *Pseudomonas* spp. lose the property of forming pigment on continued subculture and some never appear to have possessed it.

In some work done here in 1949 with the help of Dr. N. Reynolds, now of the Ministry of Agriculture and Fisheries Laboratory, Conway, on the effect of certain antibiotics on a variety of bacteria isolated from marine fish, it was noted that the types provisionally classified as *Pseudomonas* spp. could be divided into two clearly differentiated groups. Further work, which has included the use of certain vibriostatic agents^{1,2}, has now resulted in a scheme for the differentiation of the *Pseudomonadaceae* of Bergey, which it is thought might be of interest to others in this field. The method employs the normal sensitivity test for antibiotics, using antibiotic tablets, or in the case of the vibriostatic agent, a saturated aqueous solution in an assay cup.

All pigment-producing pseudomonads so far studied from a variety of sources, even although they may have lost the power of pigment production on subsequent subculturing, have been found to be insensitive to the antibiotics and the vibriostatic agent at the concentrations listed in Table 1. On

the other hand, all the *Vibrios* so far tested react to both terramycin and the vibriostatic agent. Indeed, many of the types from fish, provisionally classified as *Pseudomonas* spp., now appear by this test to be *Vibrios*. The remaining group of *Pseudomonas* spp., which grow somewhat slowly and never form pigment under any conditions so far tested, can also be distinguished by their sensitivity to terramycin (Table 1). Admittedly the total number of strains tested has been relatively small (about two hundred) and future work may well reveal many exceptions. It is considered, however, that such a scheme may well surmount the difficulties of identifying non-pigmented strains of *Pseudomonas* spp. from clinical material, mentioned recently by Gaby and Free³.

An extension of this work to the other groups of asporogenous non-pigmented rods has resulted in a sensitivity scheme which, together with morphology, reaction to Gram's stain, etc., can quickly differentiate between the main groups of *Pseudomonas*, *Achromobacter* and *Bacterium* (Table 2 and Fig. 1). This provisional scheme has been found particularly useful in the preliminary screening and grouping of several hundred primary isolates from fresh fish⁴, and other workers faced with similar problems may find that some such scheme could be adapted to their own field. Further work with other species both from

marine and terrestrial sources is proceeding. A full account will be published elsewhere.

We are indebted to Dr. H. O. J. Collier, Pharmacology Department, Allen and Hanburys, Ltd., Ware, Herts, for the gift of a generous sample of the vibriostatic agent.

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Effect of Experimental Tuberculosis on the Distribution of Alkaline Phosphatase in the Adrenal Cortex of the Guinea Pig

It has been reported earlier that stressor agents like epinephrine¹ and adrenocorticotrophic hormone² cause a loss of alkaline phosphatase activity from the adrenal cortex. Administration of serum gonadotrophin to epinephrine-treated pigeons partially prevents this enzymatic loss³. The present communication records an attempt to determine whether a comparable reduction in alkaline phosphatase activity occurs in the adrenal cortex in response to a bacterial infection stress.

Twelve male guinea pigs weighing on an average 520 gm. were used in this work. Six animals were injected subcutaneously with a human strain of tubercle bacilli (H37RV) of tested virulence, in a dosage of 1 mgm. (wet weight of the inoculum emulsified in 1 c.c. of 0.9 per cent physiological saline solution) per animal. The inoculated animals were killed after eight weeks and post-mortem findings revealed extensive tubercular lesions with caseation in the lungs, liver, spleen and the lymphatic glands. The control animals were injected with 1 c.c. of physiological saline solution in a similar manner and were killed along with the infected animals. Prior to killing, all the control animals were tested with tuberculin and were found to give a negative reaction. The adrenals were carefully dissected out and processed according to the technique of Gomori⁴ for the demonstration of alkaline phosphatase.

In the control guinea pigs, the glomerular zone exhibits intense phosphatase activity. The entire area appears as a dark band and the contours of the parenchymal cells are totally obscured by granular deposits of cobalt sulphide (Fig. 1). In the outer fasciculate the nucleus of the parenchymal cells reacts in a strong positive manner; but the distribution of the enzyme is somewhat diffuse in the cytoplasm. The endothelium of the vascular sinusoids of this area, however, shows pronounced phosphatase activity. In the inner fasciculate and the reticularis, on the other hand, the parenchymal cells are virtually devoid of enzyme activity. This is also the case with the endothelium of the vascular sinusoids of these areas.

Macroscopically, the adrenals of the infected guinea pigs are considerably enlarged in size; this could be ascribed mainly to the hypertrophy of the cellular parenchyma of the fasciculate zone. The glomerulosa shows no histological response to tuber-

cular infection, and no pathological changes could be detected in any part of the cortex. Cytochemically, a pronounced loss of phosphatase activity is clearly evident upon microscopical examination. In the outer fasciculate the parenchymal cells react only in a faint manner, and similarly the endothelium of the vascular sinusoids of this area. The inner fasciculate and the reticularis are totally devoid of phosphatase activity. Considerable amounts of the enzyme, however, are retained in the glomerular zone (Fig. 2).

It is therefore evident that the above findings agree with previous work¹⁻³ and indicate that in a bacterial infection stress also there is marked loss of phosphatase activity from the adrenal cortex. The enzymatic loss is probably associated with the rapid metabolism and subsequent decline in critical lipids known to occur during stress conditions. It is interesting that plasma alkaline phosphatase activity in rats shows a comparable reduction in response to adrenocorticotrophic hormone stress⁴.

I wish to thank Dr. B. Mukerji for the interest he has taken in this study, and Dr. S. K. Gupta for valuable help.

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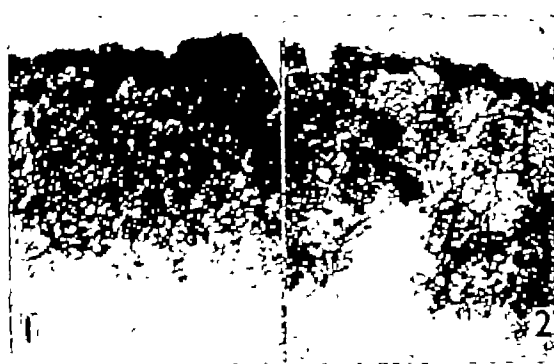
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Choline Deficiency in the Guinea Pig

THE brief report by Reid¹ of the "production of clear-cut deficiencies of . . . choline . . ." in the guinea pig is of considerable interest, as Handler² had previously failed to produce fatty livers in guinea pigs maintained on a hypolipotropic diet and had correlated this failure with the low choline oxidase content of guinea pig liver³. In view of this discrepancy, we present histochemical evidence here of the centrilobular deposition of fat in the livers of guinea pigs fed a hypolipotropic diet. Such accumulation of fat is characteristic of choline deficiency in the rat⁴.

Twenty male guinea pigs of about 550 gm. weight were divided into two similar groups and fed the diet shown in the accompanying table, choline being omitted from the ration of one group. The diets were mixed with some ground osho (Purina Rabbit Chow Checkers, obtained from the Ralston Purina Co., Ltd., Woodstock, Ontario) for the first twelve days, the proportion of the synthetic diet being gradually increased to 100 per cent. The group receiving the choline-supplemented diet was pair-fed on a twice-weekly basis against the deficient group. All animals received oral supplements of ascorbic acid every three or four days. They were maintained on these regimens for as long as 160 days. Some were sacrificed at intervals before this time so that there were only three survivors in the deficient group and six receiving the supplemented diet. The average gains in weight of the longest-surviving animals in these groups were only 112 and 162 gm. respectively.

Frozen sections of the livers were studied with oil red O, sudan black B and Nile blue sulphate. The histochemical findings are illustrated by Figs. 1 and 2. Although a few fat droplets occurred in the



Photomicrographs of sections through the adrenal cortex of (1) a normal guinea pig; (2) guinea pig infected with tuberculosis. Note reduction of staining reaction. $\times 80$

COMPOSITION OF THE DIET

	Per cent		Per cent
Gelatin	1.0	Liver powder	1.0
Oseam	2.0	Salt mixture†	4.0
a-Soya protein	5.0	Vitamin mixture‡	2.0
Extracted peanut meal	12.0	Cystine	0.15
Cereogram	7.0	Choline chloride*	0.20
Starch*	10.25	Corn oil	1.0
Dextrin	10.0	Beef fat	4.0
Glucose	20.0	Cod liver oil concentrate	0.015
Sucrose	20.0	α -Tocopherol acetate	0.010

* In the preparation of the choline-deficient diet, the choline chloride was replaced by an additional 0.5 per cent starch.

† The salt mixture contained the following per kgm.: calcium carbonate, 117 gm.; calcium acid phosphate, 885 gm.; dipotassium phosphate, 775 gm.; magnesium sulphate, 100 gm.; sodium chloride, 150 gm.; iron citrate, 50 gm.; manganese sulphate, 1.945 gm.; zinc sulphate, 0.350 gm.; copper sulphate, 0.400 gm.; potassium iodide, 0.005 gm.; sodium fluoride, 0.005 gm.; potassium alum, 0.040 gm.; cobalt chloride, 0.005 gm.; sodium silicate, 0.20 gm.; and sodium arsenite, 0.010 gm.

‡ The vitamin mixture contained the following per kgm.: biotin, 20 mgm.; thiamine hydrochloride, 500 mgm.; riboflavin, 250 mgm.; pyridoxine hydrochloride, 200 mgm.; calcium pantothenate, 1,000 mgm.; nicotinic acid, 1,000 mgm.; folic acid, 50 mgm.; 2-methyl-1,4-naphthoquinone, 100 mgm.; p-aminobenzoic acid, 10.0 gm.; and sucrose, 987 gm.

§ The cod liver oil concentrate (Ayerst, McKenna and Harrison, Ltd., Montreal, Que.) contained 200,000 I.U. vitamin A and 50,000 I.U. vitamin D per gm.

periportal cells in both groups, only in the choline-deficient animals were there many fine droplets in the centrilobular cells. The liver lipids were not estimated chemically.

That more severe signs of choline deficiency were not observed may have been due to the choice of guinea pigs older than those used by Reid¹ and to their very limited growth during the experimental period. The small gain in weight may be of significance in two respects. First, it would result in a decreased demand for methionine for protein synthesis, labile methyl groups being conserved in this way². Secondly, it suggests that the relatively low caloric intake might have produced a pseudo-lipotrophic effect³. Such considerations would appear to apply also to Handler's experiments. We would suggest that the difficulty of producing fatty livers

in guinea pigs by maintenance on a hypolipotropic diet should not be attributed to the lack of hepatic choline oxidase until it is clear that the difficulty is not simply that of securing a high caloric intake in guinea pigs on an artificial diet.

This investigation was supported in part by a research grant from the National Research Council, Canada.

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Steroid Requirements of Housefly Larvae

It has been known for some time that with very few exceptions¹ insects require only the unsaponifiable, not the saponifiable, fractions of lipids. According to Hobeon, for example, the larvae of *Lucilia sericata* require cholesterol as an extraneous growth factor, and they are capable of synthesizing neutral fat from a lipid-free peptone diet under sterile conditions. Since then, many insects have been found to require a sterol (zoosterol, phytosterol or mycoosterol) as growth factor.

This communication describes some preliminary experiments on the specificity of steroids as growth-factors for the housefly (*Musca vicina* Macq.). The experiments, which form part of a more comprehensive study², were carried out with larvae on a diet composed of wheat bran and water (1:1), which had been inoculated with a standard bacterial flora (*E. coli*, *Sarcina lutea*, *Lactobacilli* and *Bacillus subtilis*). All experiments were carried out at $35 \pm 0.5^\circ$, and the weight increase (daily) and pupation time of the larvae were recorded. It has, of course, been shown³ that the above bacteria do not synthesize the lipids required by the larvae. Fig. 1 (p. 212) shows that a lipid-free diet, that is, a diet extracted exhaustively with chloroform (curve a), retards the development of the larvae (both in time and in weight) and practically prevents pupation. Cholesterol or sitosterol (curve b) in a quantity of 0.17 per cent (the normal sterol content of the wheat bran used) restores the growth curve to normal: a maximum weight of 22–23 mgm. per larva is reached after four days, and between the fourth and fifth day, 100 per cent

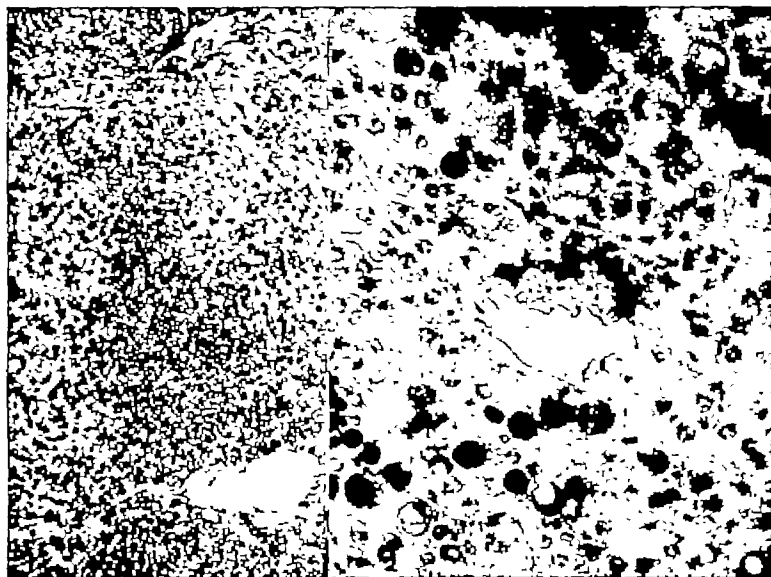


Fig. 1. Liver of guinea pig pair-fed choline-supplemented diet. A few periportal but no centrilobular cells contain fat droplets. $\times 40$

Fig. 2. Liver of guinea pig fed hypolipotropic diet ad libitum. Many centrilobular cells contain fat droplets. $\times 190$

Frozen sections of formalin-fixed tissues. Oil red O, hematoxylin and light green

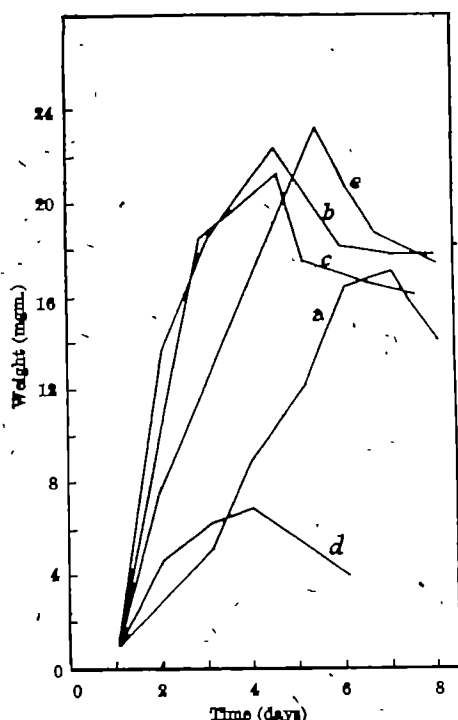


Fig. 1. Growth curves of the pre-adult stages of *Musca vicina* reared on various diets: (a) chloroform-extracted wheat bran; (b) extracted wheat bran, after addition of 0.17 per cent cholesterol or sitosterol; (c) extracted wheat bran, after addition of 0.17 per cent Δ^4 -cholesten-3-one; (d) extracted or non-extracted wheat bran, after addition of 0.17 per cent cholestan-3-one or cholestan-3-ol; (e) control diet.

pupation takes place, followed by the normal weight decrease. Δ^4 -Cholesten-3-one (curve c) has practically the same effect as cholesterol, when applied in a concentration of 0.17 per cent. Cholesterol (and Δ^4 -cholesten-3-one) acts, therefore, both as growth and pupation factor; it is essential for pupation.

Very surprising was the effect of cholestan-3-one (curve d). It permitted the growth of the larvae to a weight of about 7 mgm. on the fourth day; then the weight decreased, and on the sixth day the larvae died. Exactly the same curve was obtained when unextracted wheat bran was used as culture medium and 0.17 per cent of cholestan-3-one was added. Thus the saturated ketone acts as an antimetabolite; its effect appears to be irreversible. Obviously, the larvae of *Musca vicina* are incapable of dehydrogenating the saturated sterol ring system. This is supported by the observation that cholestan-3-ol has the same effect as cholestan-3-one.

The experiments are being continued with other steroid derivatives and simpler analogous compounds.

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Synthesis of Ribose in Animal Tissues

RECENTLY, we described experiments showing the synthesis of deoxyribose in guinea pig liver extracts by the coupling of a triose with acetaldehyde¹. The substitution of glyceraldehyde for acetaldehyde as the 2-carbon compound might be expected to lead to the synthesis of ribose instead of its deoxy-derivative, and this has now been shown to occur.

The preparation of the tissues and the general analytical techniques were as previously described¹. Liver extract was incubated with glyceraldehyde (final concentration 0.08 M) together with fructose-1,6-diphosphate (0.02 M) as a source of triose; iodoacetate (0.008 M) was added to prevent triose breakdown. After incubation, the sugar-phosphate fraction was separated by precipitation with barium acetate and ethanol. Barium was removed from this fraction, and the barium-free solution acted upon by alkaline phosphatase. Analysis by paper chromatography then gave clear evidence of the presence of the two keto-pentoses, xylulose and ribulose, which must initially have been present as phosphate derivatives. These sugars showed all the reactions of authentic samples on the chromatogram, and on elution gave absorption curves with the orcinol reagent showing typical peaks at 670 m μ and 540 m μ . The cysteine-carbazole reaction (see Cohen²) was also used in identifying the sugars.

By removing samples from the incubate at different intervals, it could be shown that the formation of xylulose phosphate preceded that of ribulose phosphate (Fig. 1). It seems likely that this reaction, brought about by liver extracts, is the same as that already demonstrated in aldolase preparations of pea seeds by Forrest, Hough and Jones³, who, starting with the same substrates, were able to identify xylulose and a little ribulose as products of their reaction. Though the synthesis of ribulose phosphate by a mechanism other than the oxidative decarboxylation of hexose derivatives has not previously been reported in animal tissues, our findings agree with those of Glock⁴, who has recently shown the accumulation of a ketopentose-1-phosphate (presumed to be xylulose-1-phosphate) when triosephosphate and glyceraldehyde were incubated in the presence of liver fractions. There are also some earlier reports of similar experiments in which pentose was found but not characterized⁵.

An additional finding in our experiments was the formation of a ribose phosphate in some of the incubates. Since this pentose, like the two keto-

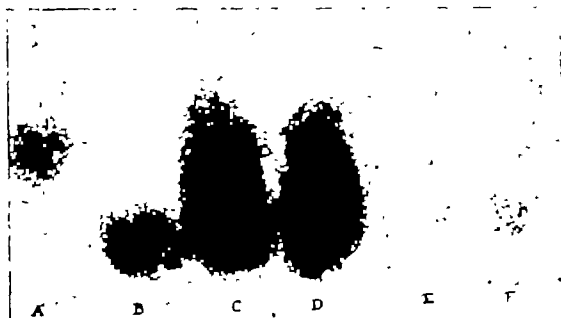


Fig. 1. Development of ketopentoses by the method of Bryson and Mitchell⁶. A, ribulose standard (green spot); B, 30 min. incubation—xylulose only; C, 1 hr. incubation—xylulose and ribulose; D, 2 hr. incubation—xylulose and ribulose; E, control (no glyceraldehyde)—no ketopentose; F, xylulose standard (blue-grey spot).

pentoses, did not appear unless both hexosediphosphate and glyceraldehyde were present as substrates, and then only after the formation of xylulose, it is most unlikely that it was the product of the oxidative decarboxylation of hexose compounds. The evidence suggests that the synthesis was the result of the coupling of dihydroxyacetone phosphate and glyceraldehyde to give xylulose-1-phosphate, and the successive conversion of this compound to a ribulose phosphate and thence to ribose phosphate.

Since liver tissue has been shown to contain a pentose-phosphate isomerase⁶, the synthesis of ribose in a system already giving rise to ribulose phosphate might be expected; the conversion is established as an essential step in the formation of ribose by the oxidative decarboxylation of hexose derivatives⁷. The mechanism of the formation of ribulose phosphate from xylulose phosphate, involving an inversion at carbon-3, is less readily explained, though it could be regarded as bearing some analogy to the conversion of glucose to galactose for which a specific waldenase enzyme system exists⁸, or to the interconversion of ribulose and arabinose, for which an enediol intermediate has been suggested⁹. It seems clear, however, from these experiments that, contrary to earlier views, ribose-like deoxy-ribose can be synthesized in animal tissues by a condensation of 2-carbon and 3-carbon compounds.

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Prosthetic Group of Cytochrome a_2

CYTOCHROME a_2 , which is found in certain bacteria, for example, *Aerobacter aerogenes* and *Azotobacter*, has particular interest as it may play the part of a cytochrome oxidase in these organisms. The main absorption band of this cytochrome in the visible part of the spectrum is in the red region: reduced, 630 m μ ; oxidized, 645 m μ ; carbon monoxide complex, 635 m μ . Spectroscopic similarities to some ferroporphorobides¹ as well as to certain bile pigment iron complexes² have been observed.

We have now obtained haemin a_2 free from protohaemin. *A. aerogenes* was cultivated under conditions of vigorous aeration by which the cytochrome a_2 content is increased³. The haemins were extracted with acid-acetone and, after removal of phospholipids, the green haemin a_2 was separated from protohaemin by precipitation of the latter by benzene.

The acid haematin (in glacial acetic acid) has a principal maximum of absorption at 603–5 m μ and a smaller maximum, of one-fifth the height, at 750 m μ . The alkaline haematin shows a maximum

at 662–64 m μ , the haem at 618 m μ , and the pyridine haemochromogen at 613–15 m μ . Cyanide forms a compound with haematin a_2 in alkaline solution, causing the disappearance of the band at 662 m μ ; on reduction with dithionite, a band appears at 618 m μ . Carbon monoxide also reacts with haem a_2 ; the band has the same position as that of the haem, but is of greater intensity.

By removal of the iron from the haemin by means of the ferrous acetate-hydrochloric acid or the ferrous formate method a chlorin-like pigment is obtained. Re-introduction of the iron restores the spectrum of haematin a_2 . In neutral solvents this chlorin has two principal maxima of absorption. In dioxane they are 654 m μ and 503 m μ . Three much weaker bands are found at 597, 572 and 533 m μ . The Soret band has a maximum at 405 m μ . In 10 per cent hydrochloric acid a maximum is shown at 630 m μ . The position of these maxima differs from those of the chlorins, pheophorbides or rhodins, for which data are recorded in the literature.

The 'HCl number' of the free chlorin is close to that of protoporphyrin; but the R_F value of the methyl ester of the chlorin when run on paper chromatograms using the kerosene-chloroform or kerosene-propanol solvents of Chu *et al.*⁴ is markedly less than that of protoporphyrin ester.

Lipoid material remains even in the purest preparations. It is possible that, like porphyrin a^1 , the prosthetic group of cytochrome a_2 possesses a lipophilic side-chain.

When the chlorin and the haematin were treated with hydroxylamine by the methods of Lemberg and Falk⁵, there was no shift in the position of the band at 652 m μ of the chlorin in pyridine or the band at 615 m μ of the pyridine haemochromogen. Thus it is unlikely that the side-chains of the prosthetic group possess a formyl or carbonyl group.

The evidence for assuming that this haemin and chlorin were derived from cytochrome a_2 is as follows. The intensity of the acid haematin band at 603 m μ , or of the chlorin band at 652 m μ in acetone, was proportional to that of the cytochrome a_2 band. *Azotobacter vinelandii*, *Escherichia coli* and *Proteus vulgaris*, all known to contain cytochrome a_2 , yielded this haemin and chlorin. When the bacteria were grown anaerobically, neither cytochrome a_2 , haemin a_2 , nor chlorin was obtained. Some organisms such as *Bacillus mycoides*, *Bacillus subtilis* and *Pseudomonas aeruginosa* developed relatively small amounts of cytochrome a_2 when grown in liquid medium with vigorous aeration, and correspondingly gave small amounts of this haemin and chlorin.

We therefore conclude that the isolated haem and chlorin are the prosthetic group and iron-free prosthetic group, respectively, of cytochrome a_2 .

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Cysteine and Phosphoserine containing Peptide Sequences of Ovalbumin

To investigate whether certain amino-acid sequences, for example, cysteinylglycine¹, occur with greater than chance frequency in different proteins^{2,3}, a method has been devised for the isolation and identification of cysteine containing sequences, and for peptide sequences containing O-phosphoserine, a compound with which at least one of the two phosphorus residues in ovalbumin⁴ has now been identified. 2-gm. portions of four times crystallized, performic acid oxidized⁵ ovalbumin were precipitated and washed with trichloroacetic acid, hydrolysed with 40 ml. of 11 N hydrochloric acid for 3-7 days at 37°, and hydrochloric acid removed *in vacuo* below 25°. A strongly acid peptide fraction was separated from the hydrolysate by washing through a 4 cm. x 10 cm. 'Dowex 50' (H⁺ form) column with water, and the effluent was dried *in vacuo*, neutralized in small volume, and applied to a 1 cm. x 50 cm. 'Dowex 2' column (pH 3, Cl⁻ form). Slow elution with 400 ml. hydrochloric acid rising continuously from 0.001 to 0.05 N provided fractions containing only one to three peptides, separable by one-dimensional paper chromatography. Composition and N-terminal amino-acid of each peptide were determined by paper chromatography of sealed-capillary hydrolysates (11 N hydrochloric acid, at 110°) of aliquots, with and without treatment with dinitrofluorobenzene⁶.

Essentially all the strongly acid components of a seven-day hydrolysate have been identified (Table 1); they include eleven dipeptides of cysteic acid (theoretical maximum fourteen, assuming no duplications⁷). Because of its acidity and composition (cf. Perlmann⁸), chromatograms of the one peptide lacking cysteic acid, aspartyl (glutamic acid, serine), were sprayed with the reagent of Hanes *et al.*⁹, after marking ninhydrin-positive spots. The presence of phosphorus was readily demonstrated.

Table 1. PEPTIDES IDENTIFIED IN A SEVEN-DAY HYDROLYSATE OF OVALBUMIN

In order of elution from 'Dowex-2' columns:

cysteyl (alanine, valine)	threonylcysteic acid	cysteic acid
cysteylalanine	valylcysteic acid*	aspartyl (glutamic acid, serine)*
cysteylglutamine	cysteylglutamic acid*	cysteylphenylalanine
cysteylvaline	phenylalanyl cysteic acid	aspartylcysteic acid
cysteylcysteic acid	glutamylcysteic acid*	

* Identified in relatively small amounts in only one hydrolysate.

When performic acid oxidation was omitted, most of the peptides passing through the cation exchanger contained phosphorus, and were then easily purified because of their small number. Free phosphoserine was identified by comparison of its *R_F* and that of its dinitrophenyl derivative in three solvents with corresponding authentic samples (gift of Dr. William H. Summerson), and traces of it were usually also found in hydrolysates of its peptides (Table 2). Since only two dipeptides of phosphoserine were identified, it is likely, though not certain, that they belong to the same sequence, aspartylphosphoserine-alanine (aspartylserinephosphoserine and phosphoserinealanine would not be expected to survive the partial hydrolysis), and that isoleucine and glutamic acid are joined to this sequence, but not directly to phosphoserine. Analyses¹⁰ of an acid hydrolysate of each dipeptide (Table 2) suggest equimolar ratios, considering serine destruction, under these conditions.

Table 2. PHOSPHORUS-CONTAINING COMPONENTS FROM OVALBUMIN

	Amounts in micromoles isolated from 1 gm. protein			
	Phosphorus Before hydrolysis	Phosphorus After hydrolysis	Serine	Aspartic acid
Phosphoserine	0	0.27	0.25	0.32
Aspartylphosphoserine	0.03	1.03	0.58	1.18
Phosphoserinealanine				
Aspartyl (glutamic acid, phosphoserine)*				
Aspartyl (alanine, glutamic acid, isoleucine, phosphoserine)				

* Identified in relatively small amounts in only one hydrolysate.

Since C-terminal serine peptides have not previously been found in acid hydrolysates¹¹, the isolation of aspartylphosphoserine from 3- (though not 6-) day hydrochloric acid hydrolysates supports the view that the acid lability of serine-amino peptide bonds is due to N to O acyl migration⁸. The successful application of these methods to ribonuclease¹², and particularly the association of aspartic acid, glutamic acid and isoleucine¹³, and alanine¹⁴, with phosphoserine in casein, encourage a search for systematically recurring sequences in proteins. This, as well as studies on the role of glutathione as precursor of the cysteinylglycine of ovalbumin, will be reported elsewhere.

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Coproporphyrin Formation in Yeast

In recent articles in *Nature*, Keilin¹ has described the occurrence of haemoglobin, in very low concentration, in certain strains of bakers' yeast, and Keilin and Thiersch² have likewise demonstrated the presence of haemoglobin in the mycelia of the moulds *Neurospora crassa* and *Penicillium notatum*. In the latter investigation, free protohaem was also found, especially in fragments of mycelium undergoing autolysis, following their projection from the aerated nutrient on to the walls of the containing vessel. The free haem in the moulds appeared to originate from intracellular haemoglobin and from some components of cytochrome by an enzymic degradation which accom-

panied the autolysis of the mycelium. In old mycelia, the free hem itself was further degraded with liberation of iron and the formation of free porphyrin. These important findings are particularly relevant to the study of porphyrin formation in autolysing yeast.

Experiments with top-fermentation brewers' yeast have shown considerable increase in yield of porphyrin following treatment with solid ammonium carbonate and glucose¹, to yield coproporphyrin isomers I and III in varying proportion, but with traces only of proto- and deuterio-porphyrins. Coproporphyrin in the medium was itself undergoing change, and apparently accumulated owing to the relative rates of formation and removal being out of phase⁴. Exogenous added cytochrome and catalase were destroyed in the yeast preparation, but did not augment the yield of coproporphyrin. From observations on the effects of various chemical agents, it was concluded that coproporphyrin probably did not arise from by-products of fermentation, but possibly as a result of rapid proliferation of the yeast cells, using ammonium carbonate as a ready source of carbon and nitrogen.

Further studies have been made on the relationship of coproporphyrin concentration to other aspects of yeast metabolism, such as respiration, fermentation and cell division. To facilitate sampling, the yeast was diluted with distilled water after it had been subjected to ammonium carbonate-glucose treatment. The addition of water was responsible for much lowered yield of porphyrin.

The results now obtained do not support the earlier view⁴ that the yeast cells in the ammonium carbonate-glucose preparation are growing rapidly. An early fall in the total cell count was observed, which may have arisen from the combined effects of restricted oxygen supply to a medium densely packed with cells⁵, and of plasmolysis of many cells, causing them to resemble cellular debris, overlooked in counting. The majority of cells enumerated at 21 hr. were granular in appearance. Rates of respiration and fermentation also showed a decline, indicating that the predominating changes in the yeast were autolytic in character. Also, coproporphyrin concentration was independent of the rates of cell division, respiration and fermentation.

The evidence points to formation of coproporphyrin in these yeast preparations, not through excessive synthesis in actively dividing cells, but rather by catabolism of preformed intracellular hemoproteins in damaged or dead cells, as described in mould mycelium³. Although earlier work⁴ has shown no conversion of added exogenous cytochrome *c*, catalase or (unpublished observations) human hemoglobin, this does not exclude such endogenous hem derivatives as possible sources of porphyrin. Moreover, the frequent occurrence of free hem in extracts, and the conversion of proto- to coproporphyrin in yeast, lend support to this hypothesis. Addition of protoporphyrin 9 to yeast alone resulted in increased formation of coproporphyrin as shown in Table 1.

Table 1. COPROPORPHYRIN IN YEAST FOLLOWING ADDITION OF PROTOPORPHYRIN 9

1 mgm. protoporphyrin added to 100 gm. top-fermentation brewers' yeast, and coproporphyrin and residual protoporphyrin measured after 24 hr.

Coproporphyrin present (μgm.)		Protoporphyrin recovered (μgm.)
control	100 gm. yeast + protoporphyrin	
102	418	72

The increased yield (316 μgm.) of coproporphyrin associated with the disappearance of 928 μgm. protoporphyrin 9 suggests that yeast is able to convert protoporphyrin 9 into coproporphyrin, and the latter could arise from a protohem derivative.

The events leading to porphyrin formation may be conceived as follows. Cytological damage liberates intracellular hemoproteins from structures inside the yeast cell, and thus renders these pigments accessible to the action of proteolytic enzymes. Attack upon and digestion of the protein moiety of the hemoprotein liberates the hem group, and from this porphyrin is readily derived.

The mode of action of ammonium carbonate and glucose, by which regular, marked facilitation of porphyrin production is achieved, remains for study. Glycine, urea, acetamide, glutamic acid, *d*-glucosamine and asparagine were all without effect. It is clear, however, that porphyrin appears in yeast through processes quite dissimilar from those liberating it during hemopoiesis in man, in which coproporphyrin forms part of the biosynthetic pathway from glycine to hemoglobin.

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Human Visual Purple and Absolute Threshold

I HAVE just read the interesting communication by Drs. Crescitelli and Dartnall on human visual purple (rhodopsin)¹. The last paragraph of that article may give rise to the impression that new evidence has been brought forward, as a result of which the work of Hecht, Shlaer and Pirenne² on the minimum number of light quanta necessary for vision might have to be considerably revised. Such an impression would, I think, be mistaken. Crescitelli and Dartnall were able to repeat and confirm König's³ measurement, made in 1894, of the optical density of the rhodopsin extracted from a human retina. On such a basis König calculated the percentage *p* of the light incident on the human retina which should be absorbed by the rhodopsin contained in the living rods, and found *p* = 4 per cent for $\lambda = 0.51 \mu$. Crescitelli and Dartnall now find *p* = 3.5 per cent. König's result was quoted and taken fully into account in the above paper by Hecht *et al.* Crescitelli and Dartnall's work, however valuable in other respects, affects but little the outcome of the discussion.

The small difference found by Crescitelli and Dartnall between frog and human rhodopsin is irrelevant with regard to the higher value, *p* = 20 per cent, which Hecht *et al.* chose as a basis for their calculations. It would have tended to increase, rather than to decrease, this value. This cannot be discussed here, but a more important fact is that the 20 per cent value was purposely chosen as an upper limit by Hecht *et al.* Such a limit was required because, when that paper was written, the main

point of interest was to establish that the minimum number n of quanta actually involved in a visual act must be very small, namely, of the order of 10 or less, instead of about 50 as had usually been believed hitherto⁴. Hecht *et al.* wrote: "From the comparison it is apparent that the 5 per cent maximum absorption curve [of rhodopsin] describes the points [of the corrected sensitivity curve] quite well, but that the 20 per cent curve is definitely excluded because its absorption on both sides is just too high. . . . However, to be quite safe, we may take 20 per cent as the upper limit for the absorption of 510 m μ by the visual purple in the human retina after complete dark adaptation". Now, Crescitelli and Dartnall write: "Their [Hecht *et al.*] figure of 20 per cent absorption by the visual pigment was based on an indirect calculation in which it was implied that the scotopic pigments of frog and man were identical". This is, I think, somewhat misleading.

Crescitelli and Dartnall do not mention the dichroism of the retinal rods which Schmidt⁵ observed in 1938. Such dichroism seems likely also to exist in man. If so, even assuming that no losses of rhodopsin occurred in the extraction made by König and by Crescitelli and Dartnall, their values for p may be too low. If losses occurred, the true value of p must be higher still. Another source of uncertainty with regard to the retinal threshold n relates to the transmission of light by the pre-retinal eye media⁶. The problem as a whole is too complicated to be discussed here, but a word may perhaps be added in connexion with Crescitelli and Dartnall's estimate of n , which they suggest is equal to "1-3 quanta approximately". Various indirect methods prove that n is greater than 1; there is general agreement on this point among workers in the field⁷; and there are also strong reasons⁸ for believing that n is greater than 2.

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Occurrence of Dieldrin-resistance in Wild *Musca domestica* L. in England

THE ability of insects to develop a resistance to an insecticide is now widely acknowledged. It has also been shown that, where resistance to a specific insecticide exists, the toxicity of related compounds can be tolerated also, though probably to a lesser extent. This communication reports the occurrence of a high degree of resistance to dieldrin (an insecticidal product containing not less than 85 per cent of 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8a-octahydro-1,4,5,8-dimethanonaphthalene, and not more than 15 per cent of insecticidally active related compounds), in a wild strain of *Musca domestica* L. which had not been exposed to this insecticide prior to this investigation.

Trials carried out during the past summer to assess the value of dieldrin for the control of the common housefly, *Musca domestica* L., on a refuse tip in Hertfordshire, proved unsuccessful. During the past four years insecticides containing DDT and gamma BHC have been applied to control flies on this refuse tip. The development of a housefly population resistant to DDT and BHC was therefore suspected. The American workers Bruce and Decker¹ have demonstrated by controlled laboratory experiments that BHC-resistant flies show some tolerance to dieldrin. If this wild strain of houseflies was resistant to BHC, the failure of these trials with dieldrin could be explained. The resistance of the wild housefly population to DDT, gamma BHC and dieldrin was therefore investigated.

Houseflies were collected from the refuse tip and reared in the laboratory under standard conditions without further contact with insecticide. The progeny was tested, concurrently with a normal laboratory culture, against technical DDT (80 per cent *p,p'* isomer), BHC (99 per cent gamma isomer) and technical dieldrin (which contains 90-95 per cent dieldrin), formulated as oil sprays. A modification of the direct spray technique described by Kearns and Marsh² was used, the insecticides being sprayed at concentrations calculated to give approximately 10-90 per cent mortality in 24 hr. (Table 1). All tests were carried out at 80° F. and 50 per cent relative humidity.

Comparison of the strains for resistance was made on the L.D. 50 (concentration of insecticide required to give 50 per cent mortality) estimated from log-probit regression lines. The resistance of the laboratory strain was taken as 1.

Table 1. RESISTANCE TO DDT (80 PER CENT *p,p'* ISOMER), BHC (99 PER CENT GAMMA ISOMER) AND DIELDRIN OF A WILD STRAIN OF *Musca domestica* L. COLLECTED FROM A REFUSE TIP
Means of at least three repeated tests with oil-based sprays

Insecticide	Strain of <i>Musca domestica</i> L.	% Concentration (w/v) of insecticide	Mean % mortality in 24 hr.	L.D. 50 (% concentration)	Relative resistance
Technical DDT	Laboratory	0.05	22	0.09	1
		0.075	41		
		0.10	56		
		0.125	66		
		0.15	75		
	Wild (third generation)	1.00	28	1.75	19
		1.50	45		
		2.00	54		
		2.50	64		
		3.00	73		
Gamma BHC	Laboratory	0.0025	24	0.0055	1
		0.006	48		
		0.0075	56		
		0.01	72		
		0.10	12		
	Wild (fourth generation)	0.25	41	0.29	53
		0.40	63		
		0.50	72		
		0.75	86		
Technical dieldrin	Laboratory	0.0015	6	0.0045	1
		0.0025	20		
		0.006	62		
		0.01	83		
		0.50	10		
	Wild (third generation)	0.75	23	1.2	266
		1.00	43		
		1.50	57		
		1.75	70		
		2.50	86		
Pyrethrins	Laboratory	0.1	43	—	—
	Wild	0.1	37	—	—

It was not possible to test each insecticide against the same generation of flies from the wild strain, owing to insufficient numbers being available. Third generation flies were tested for resistance to DDT and dieldrin, and fourth generation flies for resistance to gamma BHC. A check test with dieldrin against the fourth generation of flies indicated that there was no difference in resistance between the third and fourth generations.

Each strain was also tested against the official test insecticide (0.1 per cent w/v pyrethrins), which is the standard prepared by the Chemical Specialties Manufacturers Association, 110 East 42 Street, New York, U.S.A., and used in many countries; 'normal' strains give 30-55 per cent mortality when sprayed with it.

The wild strain of houseflies was found to be 19 times more resistant to DDT, 53 times more resistant to gamma BHC and 266 times more resistant to dieldrin, than the normal laboratory culture (Table 1). Bearing in mind that the wild strain was resistant to gamma BHC, some resistance to dieldrin was anticipated, but the concentration of dieldrin tolerated was surprisingly high in comparison with the normal strain. There appeared to be little difference in resistance to pyrethrins.

The magnitude of dieldrin-resistance shown by the wild housefly population cannot be readily explained, as the insecticide had not been used for fly control on this particular refuse tip before these trials were undertaken.

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Nov. 20.

¹Broce, W. N., and Decker, G. O., *Soap and San. Chem.*, 36 (3), 123 (1930).

²Kearns, O. W., and March, R. B., *Soap and San. Chem.*, 19 (3), 101 (1943).

Thermo-chemical Seed Treatment

NEWHOOK¹, using the technique of Baylis², reported that a hot-water steep of 10 min. at 52.8° C. controlled seed-borne pasmo (*Sphaerella linorum* Wollenw.) in seed-lines of linen-flax (*Linum usitatissimum* L.). Watson *et al.*³ have recently reported the use of carbon tetrachloride as a suitable material in place of water for heat treatment of peas and beans. It has been shown by them that germination of peas and beans was not affected by a 60-min. steep at 75° C. Heat transfer into the seeds was demonstrated, but very little carbon tetrachloride was absorbed.

Experiments have been carried out to determine the effect of a carbon tetrachloride steep on germination and control of seed-borne pasmo in linseed. Thirty-six temperature-time combinations were studied, ranging from 5 min. to 30 min. with 5 min. variations, and from 50° C. to 75° C. with 5 deg. temperature differences.

Two varieties, namely, Golden Viking and Koto, were treated. 10-gm. lots of seed were steeped in a carbon tetrachloride bath maintained at the different temperature-levels by a Towers thermostatic control unit. Seed was germinated in Petri dishes on moist filter pads in an incubator at 22° C. for seven days. Seed was examined for viability of *S. linorum* (a) by the technique of Loughnane *et al.*⁴, followed by removal of spores to Van Teigham cells and incubation at 22° C. for 24 hr.; preparations were stained with cotton-blue lacto-phenol, and examined for the presence of germ-tubes; (b) by plating surface disinfectant seeds on 'Bacto-prune' agar in Petri dishes and incubating at 22° C. for six days.

No mucilaginous sludge developed in the course of treatment, and no carbon tetrachloride appeared to be absorbed. Results of germination counts are presented in the accompanying table. Analysis of these results showed significant depression of germination only at 70° and 75° C. for 30 min. with Golden Viking and 20 min. with Koto. These treatments also markedly reduced vigour of the seedlings, their development being two to three days slower than those of untreated seed.

In the technique used for determining spore germination, no germ-tubes were observed after treatment for 20 min. at 65°, 70°, 75° C. or for 30 min. at 80° C. In the plate tests, no cultures were obtained from seed treated for 15 min. at 70° or 75° C., 20 min. at 65° C. or 30 min. at 60° C. Untreated seed samples yielded 14 per cent infected seed (Fig. 1).

A similar experiment, using linseed infected with browning (*Polyspora lini* Laff.) and the plating technique, has also been carried out. No cultures were obtained from seed treated for 15 min. at 70° C. or 20 min. at 65° C.

From these preliminary experiments it would appear that complete control of two seed-borne diseases of linseed can be obtained by a carbon tetrachloride steep at times and temperatures which do not affect germination.

The use of carbon tetrachloride in place of water as a material for heat-treatment of linseed has two technical advantages over the latter: first, the safety limits with respect to germination are wider; secondly, no artificial drying of seed is necessary. On the other hand, a specially designed steep for elimination of fumes and recovery of carbon tetrachloride given off as a vapour during the treat-

GERMINATION RESULTS OF HEAT-TREATED LINSEED

Treatment Time	Mean percentage germination (three samples of 100 seeds)											
	Golden Viking ^a						Koto ^b					
	50°	55°	60°	65°	70°	75°	50°	55°	60°	65°	70°	75°
5 min.	82.3	88.0	87.7	83.3	80.7	81.0	96.3	91.0	97.0	90.3	90.0	86.7
10 "	74.3	88.3	86.7	82.7	72.7	83.0	91.8	91.3	93.0	92.0	92.0	93.0
15 "	82.0	83.3	87.0	86.3	76.3	81.0	93.7	91.0	88.0	89.0	87.0	92.0
20 "	82.7	71.3	90.7	76.3	74.0	72.7	97.3	96.3	93.3	84.0	82.0	96.0
25 "	86.3	79.0	81.3	81.3	73.3	79.3	90.7	90.7	94.0	91.3	80.3	94.3
30 "	83.7	86.3	86.3	88.3	68.3	67.0	89.0	97.3	92.3	85.7	76.7	81.0
Control	79.0						92.0					

^a Difference for significance at 5 per cent level = 10.0; at 1 per cent level = 13.4.

^b Difference for significance at 5 per cent level = 8.7; at 1 per cent level = 11.5.

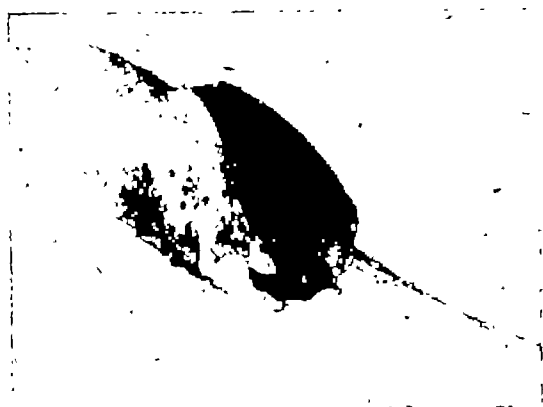


Fig. 1. Psamo-infected seed showing appearance of pycnidia on seed coat after germination in moist chamber. $\times 7$. Photograph by R. O. Blackmore

ment would be required for the efficient operation of a thermo-chemical treatment plant.

A full account of this work will be published elsewhere. Thanks are due to Miss E. Milne, Applied Mathematics Laboratory, N.Z. Department of Scientific and Industrial Research, for statistical analysis of results.

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¹ Newhook, F. J., *N. S. J. Sci. Tech.*, **34**, 103A (1943).

² Baylis, G. T. S., *N. S. J. Sci. Tech.*, **23**, 1A (1941).

³ Watson, R. D., Goltz, L., and Robinson, R., *Plant Dis. Reporter*, **35**, 542 (1951).

⁴ Loughnane, J. B., McKay, R., and Lafferty, H. A., *Sci. Proc. Roy. Dublin Soc.*, **34**, 89 (1946).

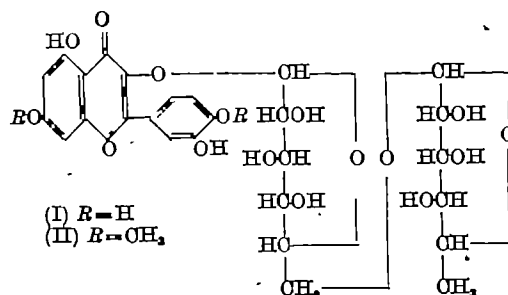
An Antagonist of the Sterility Hormone Rutin in the Green Alga *Chlamydomonas* *eugametos*: Ombuoside=7,4'-Dimethyl- rutin

RUTIN (= quercetin-3-rutinoside) prevents the copulation of male and female gametes in *Chlamydomonas eugametos*¹. Its effect is very specific. Checking more than forty flavonols, it was found that only rutin induces sterility. The sugar at carbon atom 3 (rutinose) seems to be important, as quercitrin (= quercetin-3-rhamnoside) does not influence fertility.

In 1935 a strain was obtained which could not be made to copulate². Filtrates of these *agametos* cells, like rutin, prevented the copulation of *eugametos* gametes. Thus *agametos* cells produce and secrete a sterility hormone. This hormone could be isolated from cells of a certain *agametos* mutant. It was identified as rutin³ (I).

Three enzyme systems dependent on genes are responsible for rutin formation in *agametos* cells: (1) the formation of *l*-rhamnose (gene *rha*⁺), (2) the formation of rutinose from *l*-rhamnose and *d*-glucose (gene *runo*⁺), (3) the formation of rutin from quercetin and rutinose (gene *ru*⁺). *Agametos* has *rha*⁺*runo*⁺*ru*⁺, *eugametos* has *rha*⁺*runo*⁺*ru*⁺. Quercetin could be isolated from cells of a *ru*⁰ *agametos* mutant⁴, suggesting that the biosynthesis of rutin follows the sequence given above.

However, *agametos* cells become able to copulate when the cells are kept in the dark for three days. Then the cells are practically free of rutin. They lose their ability to copulate after a period of illumination of 15–20 min. During the short period of copulation, it is possible to cross *agametos* with *eugametos*. The effect of rutin is not yet clear. It is evident that the formation or the secretion of gamones which induce the last phase of the copulation is disturbed.



We have now been able to examine ombuoside (II), a glycoside that is a 7,4'-dimethyl-rutin, which has been obtained from the leaves of the ombu (*Phytolacca dioica*, L.), where it accompanies rutin⁵. The results of the experiments are: (1) ombuoside (10^{-4} gm./ml.) shows no influence on the copulation of *eugametos* gametes; (2) *agametos* cells obtain the ability to copulate in solutions containing 10^{-4} to 10^{-7} gm./ml. ombuoside; (3) *eugametos* gametes made sterile by rutin (10^{-4} gm./ml.) begin to copulate again after adding ombuoside (10^{-4} gm./ml.); (4) *eugametos* gametes continue to copulate in solutions containing ten times more ombuoside than rutin.

We conclude from these results that ombuoside is able to compensate the rutin effect.

We also tested 7,4'-dimethyl-quercetin or ombuin, the aglycone of ombuoside. It has no influence on *eugametos* gametes. However, we found that ombuin compensates the sterility of *agametos* cells. This effect may indicate that *agametos* cells can form ombuoside enzymatically from ombuin.

The specificity of 7,4'-dimethyl-quercetin was demonstrated by examination of ten other methyl derivatives of quercetin (for which we thank Dr. I. Loew, Max Planck-Institut fuer Medizinische Forschung, Heidelberg), namely: 7-, 5-, 3-, 3', 7,3-, 3,5,3', 3,7,3', 5,7,3', 5,3',4', and 7,3',4'-methyl quercetins were without any effect on *agametos* cells. These results show that 7,4'-dimethyl-quercetin (ombuin) and 7,4'-dimethyl-rutin (ombuoside) have a special importance in this antagonism with rutin.

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¹ Kuhn, R., Moewus, F., and Loew, I., *Ber. Chem. Ges.*, **77**, 219 (1944).

² Moewus, F., *Naturwissenschaften*, **34**, 233 (1947).

³ Kuhn, R., and Loew, I., *Naturwissenschaften*, **34**, 233 (1947); *Chem. Ber.*, **81**, 368 (1948).

⁴ Moewus, F., *Portug. Acta Biol. Goldschmidt Vol.*, **151** (1949).

⁵ Martini-Bettolo, G. B., Deulofeu, V., and Hug, B., *Gen. Chim. Ital.*, **80**, 63 (1950); Deulofeu, V., Mohr, B., and Hug, B., *Gen. Chim. Ital.*, **80**, 720 (1952).

Distribution of Radio-Frequency Brightness across the Solar Disk and the Derivation of a Model Corona

DETERMINATIONS of the distribution of radio-frequency brightness across the solar disk have been made by Stanier¹ at a wave-length of 80 cm. and by Machin² at a wave-length of 3.7 metres. A series of similar observations has been carried out by one of us³ at wave-lengths of 1.4, 3.7 and 7.9 metres during the period July 1951–July 1952. In this communication we describe the results of an attempt to derive a model of the corona which is consistent with these observations⁴.

made about N or T ; instead, an attempt was made to derive these quantities directly from the radio observations. The model which was found to fit the observations most closely was given by:

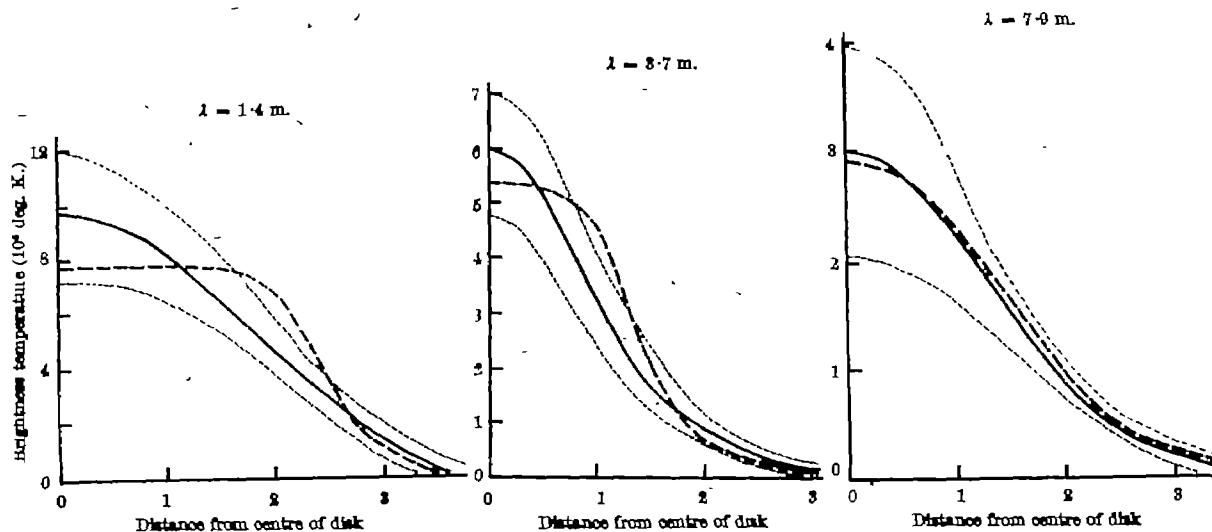
$$N = 1.6 \times 10^8 R^{-1} \text{ cm.}^{-3}$$

$$T = 2 \times 10^6 R^{-2} \text{ deg. K.}$$

over the range $R = 1.2 R_s$ to $3.0 R_s$, where R_s is the radius of the photosphere.

This distribution of electron density agrees well with that of Allen for small values of R , but for R greater than $2R_s$, the density decreases more slowly outwards.

The extent to which the new model can account for the observations is shown in the graphs. It is



Distribution of radio brightness across the solar disk at three wave-lengths. The distance from the centre of the disk is given in terms of the radius of the photosphere (R_s).

—, Experimental curves; limits within which the experimental curves are believed to fall; ---, theoretical curves

The experiment showed that the contours of constant radio brightness were roughly elliptical in form and varied slightly from day to day. As a first approximation for the purposes of theoretical interpretation, they were replaced by constant circles. The average radial distributions which were used in this way to represent the experimental results are shown as continuous lines in the accompanying graphs. The uncertainty of the experimental results is indicated by the dotted lines, which show the limits within which the distributions are believed to fall. The limits are predominantly caused by an uncertainty in the absolute scale of brightness (because small errors in the distribution for large radii can introduce large errors in the determination of the central temperature). There is also some uncertainty in the results arising from the day-to-day variations.

Smerd⁵ has derived theoretical curves for the distribution of brightness for a number of wave-lengths, assuming the coronal electron density, N , given by Allen⁶ and a number of uniform temperatures, T . It is clear from a comparison of the observations with these theoretical curves that a coronal model with uniform temperature cannot account for the observations, and, in particular, that it cannot provide sufficient intensity at large radii.

If the electron density derived by Allen is retained, analysis showed that these discrepancies could not be removed by assuming that the temperature varied with height in the corona. A new method of analysis was therefore adopted in which no assumptions were

seen that a satisfactory fit is obtained for $p > 1.5 R_s$ (where p is the distance from the centre of the disk), which is the important region where Smerd's curves show the greatest discrepancy with observation. For values of p between $0.5 R_s$ and $1.5 R_s$, the intensity at 1.4 and 3.7 metres is somewhat greater than that observed. It seems likely, however, that this remaining discrepancy may be removed when it has been possible to allow for the effects of scattering by irregularities of electron density in the corona. Some information about these irregularities for $R > 5 R_s$ has recently been obtained by Hewish⁷ from observations of the occultation by the solar corona of the intense radio source in Taurus. It is possible that the inclusion of the scattering effects in the analysis may result in some modification to the values of N and T derived above.

This work was carried out as part of a programme of radio research at the Cavendish Laboratory, supported by the Department of Scientific and Industrial Research.

P. A. O'BRIEN
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Cavendish Laboratory,
Cambridge. Dec. 14.

¹ Stanier, H. M., *Nature*, **165**, 554 (1950).

² Machin, K. H., *Nature*, **167**, 889 (1951).

³ O'Brien, P. A., *Mon. Not. Roy. Astr. Soc.*, **113**, No. 5 (1953).

⁴ Ryle, M., *Volta Convention Proc., Accademia Nazionale dei Lincei*, **275** (1952).

⁵ Smerd, S. F., *Aust. J. Sci. Res.*, **3**, A, 84 (1950).

⁶ Allen, C. W., *Mon. Not. Roy. Astr. Soc.*, **107**, 426 (1947).

⁷ Hewish, A. (in preparation).

Television Pick-up Tube for both Light and X-Ray Pictures

INVESTIGATIONS carried out on television camera tubes using the photoconductive effect for converting a light image into an electrical signal have resulted in the development of an experimental tube sensitive to both visible light and to X-rays.

The photoconductive material used in the tube is suitably activated lead oxide, evaporated on a 'Pyrex' glass window. The layer is scanned by a low-velocity electron beam, as described by Weimer, Forgue and Goodrich¹.

The light sensitivity, the peak of which is in the blue part of the spectrum, amounts to about 100–200 microamp. per lumen when an incandescent light source at a colour temperature of 2,600° K. is used. The speed of response is sufficient to make the tube suitable for industrial applications and shows promise for application in television broadcasting.

The relatively good sensitivity to X-rays is the result of the high absorption coefficient of lead oxide for this radiation. A layer of only 5 microns thickness absorbs about 5 per cent of the radiation originating from an X-ray tube operated at 70 kV. D.C., the radiation being filtered by 5 mm. aluminium. The 1.2-mm. thick 'Pyrex' face on which the lead oxide has been applied absorbs about 10 per cent.

The accompanying photographs have been taken from a television monitor tube. Fig. 1 represents a

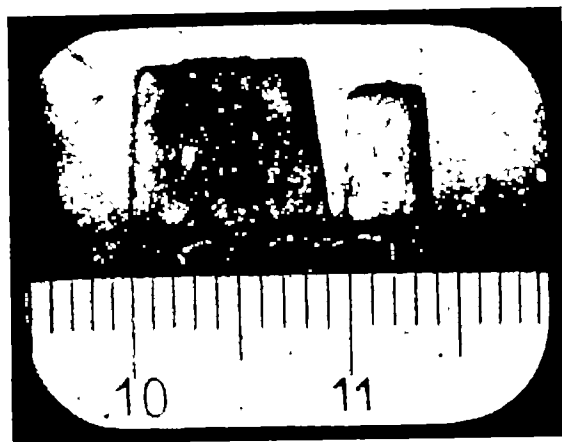


Fig. 1

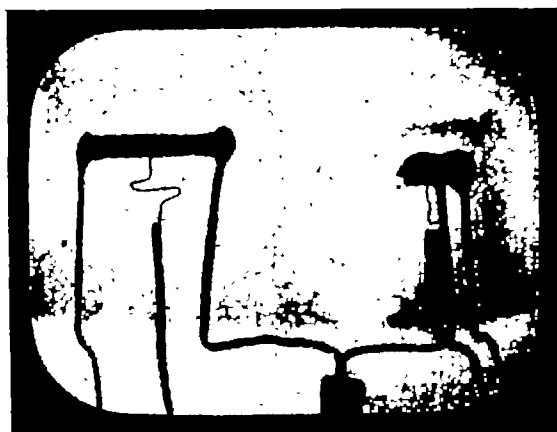


Fig. 2

picture produced by the pick-up tube combined with a lens, the object being two identical transistors with a centimetre scale giving an impression of the dimensions. The 'scene' is illuminated with visible light. Fig. 2 shows a picture produced by the pick-up tube when the same transistors were placed in front of the tube face and irradiated by X-rays (X-ray shadow picture). The X-ray source consisted of a Philips's 'Practix' operated with 10 mA. at 72 kV. A.C. and placed at a distance of 70 cm. from the object. In the picture on the monitor tube the statistical noise of the X-ray quanta predominated over the amplifier noise.

It is thus possible to make an enlarged X-ray picture of small objects. The pick-up tube has a usable area of 20 mm. diameter, whereas the photograph was taken from a monitor with 35 cm. diagonal.

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Eindhoven, Netherlands.
Nov. 30.

¹ *RCA Rev.*, 12, 306 (1951).

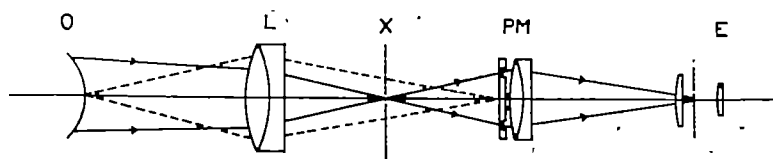
A Phase-Contrast Searcher for the Burch Reflecting Microscope

It is important in the ultra-violet microscopy of biological material to be able to search for and focus the specimen with visible light so that ultra-violet irradiation can be kept to a minimum. As the material examined is normally unstained, little detail can be seen using conventional illumination with the microscope.

To overcome this difficulty, the original Beck-Barnard ultra-violet microscope, produced in 1926, possessed a dark-ground illuminator built around the quartz condenser¹. The modern counterpart of this instrument, made by Cooke, Troughton and Simms, has a special phase-contrast condenser unit, and in this way an immersion visual phase-contrast objective can be used for preliminary viewing and focusing of the specimen². In the system designed by Walker and Davies³, focusing is performed in visual phase contrast with the aid of an auxiliary lens and phase plate, introduced behind the objective.

These systems have been used in conjunction with refracting objectives; but it is clear that a similar type of phase-contrast searcher would be of great use with the Burch reflecting microscope. The problem here is somewhat more difficult. By tracing a ray through the optical system, it can be shown that the small mirrors of the condenser and objective can be regarded as conjugate levels. Thus the annulus and phase plate could be ideally located at these mirrors. The introduction of these components to reproducible positions at the small mirrors presents serious mechanical difficulties and therefore was not attempted.

In the illumination system coupled to the Burch microscope, the condenser aperture is controlled by means of an aperture stop imaged at the condenser small mirror; thus the annulus can be located conveniently at this stop. In a similar way, it becomes necessary to image the objective small mirror to a more accessible position. In the system designed by Payne⁴, an image of the back focal plane of an



Optical system for phase contrast (not to scale)

objective is formed in an accessible position by means of a concave mirror, the light being deflected to a side tube attached to the microscope. Francon and Nomarski⁵ introduced phase contrast in the microscope by means of an eyepiece system, a projection eyepiece forming an image of the back of the objective at the phase plate, which was of strip form. Due to the long optical tube-length (34.5 cm.) of the Burch reflecting microscope, such a lens at the eyepiece level would produce an exceedingly small image of the annulus if the optical system was to be kept to a reasonable length.

To overcome this difficulty, without deflecting the light to a rather inconvenient side-tube, the system shown in the diagram has been adopted. The lens *L*, situated within the microscope body-tube, images the objective small mirror *O* at the phase plate *P* at approximately unit magnification. This lens also causes the main image-forming beam to converge at *X*. The phase plate is attached to the front surface of a low-power microscope objective *M* (3 in. focal length), which is focused on the image of the specimen at *X*. Thus the final image viewed through an eyepiece *E* appears under phase-contrast illumination. The definition of the image is good, but the curvature of field is rather high, the low-power microscope objective introducing field curvature additional to that of the reflecting objective itself. This has the effect of reducing the diameter of flat field from about 140 μ to 70 μ , a defect which is of little importance for searching purposes.

In the actual system used on the microscope, the lens *L* is a telescope objective of short focal length and has not been specially computed for the purpose. It produces a well-corrected image of the specimen; but in forming an image of the annulus, the lens is working at conjugates for which the correction is poor. It is therefore advisable for the phase ring to be wide relative to the annulus; chromatic aberration, which produces colour over the whole object field, can be restricted by using green light.

This auxiliary optical system can be introduced into the microscope quite easily. The lens *L* is swung into the light beam, while the tube containing phase plate, microscope objective and eyepiece fits into the eyepiece tube of the Burch microscope. Set up in this way, the system greatly facilitates searching the specimen, prior to photomicrography and absorption measurements in the ultra-violet.

This work has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

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Royal Cancer Hospital,
London, S.W.3. Dec. 10.

¹ Barnard, J. H., and Welch, F. V., "Practical Photomicrography", 301 (1936).

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Crystal Structure of Glycyl-L-Alanine Hydrobromide

INTEREST in the crystal structures of simple peptides has increased considerably, during recent years on account of progress made in the direct investigation of protein structure. Glycyl-L-alanine hydrobromide has been prepared in these laboratories and examined by X-ray methods. The free dipeptide was prepared by the N-carbobenzoxy method¹ and then converted into the hydrobromide which crystallized readily from aqueous solution.

The crystal data for glycyl-L-alanine hydrobromide are $a = 10.89$ Å.; $b = 6.13$ Å.; $c = 7.63$ Å.; $\beta = 108^\circ 34'$. The density (by flotation) is 1.714 gm./c.c. The number of molecules per unit cell is 2 mol. glycyl-L-alanine + 2 mol. of water of crystallization. Space group, P_1 .

The intensities of 154 Å. reflexions were measured visually using copper $K\alpha$ radiation, and the Patterson projection on (010) showed a clearly resolved peak attributable to the Br-Br vector. From the position of the heavy atom the signs of a large proportion of the structure factors could be derived, and from the preliminary Fourier projection the signs of the

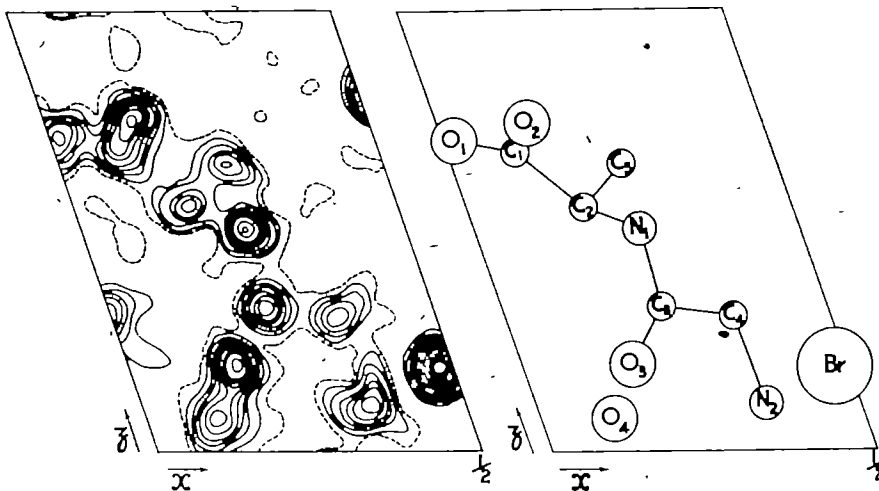


Fig. 1

Fig. 2

remaining terms were obtained. The resulting projection is shown in Fig. 1 and is adequate for placing the atoms in the unit cell, with all the atoms, including the water molecule O_4 , being resolved with the exception of C_1 and O_3 (see Fig. 2).

A preliminary examination of the structure using y -co-ordinates derived by assuming probable bond-lengths for the glycyl-L-alanine molecule showed satisfactory hydrogen-bonding, the glycyl-L-alanine and water molecules forming spirals bound together laterally by N—H bonds. A detailed discussion of this aspect will, however, be postponed until the structure has been refined using the hydrochloride, which is isomorphous with the hydrobromide.

T. C. TRANTER

Wool Industries Research Association,

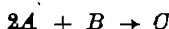
Torridon,

Headingley, Leeds 6. Oct. 16.

¹ Bergmann, M., and Zervas, L., *Ber. Deut. Chem. Ges.*, **65**, 1102 (1932).

Formulation of the Rate Equation in Chemical Kinetics

ROBB¹ has recently pointed out that when the rate-constant for a reaction such as



is under discussion, it is necessary to state whether the rate referred to is the disappearance of A or of B , since the latter is half as fast as the former.

It is perhaps also worth pointing out that in the academic literature of reaction kinetics, rates are always written as rates of change of concentration in a closed system which is tacitly assumed to be at constant volume; for example:

$$-\frac{d}{dt}[A] = -2\frac{d}{dt}[B] = k[A]^2[B]. \quad (1)$$

This equation has only limited application to industrial processes. There are closed reaction systems, for example, in which the volume changes during the reaction, and open systems (such as continuous-flow tank and tubular reactors) in which the concentration is independent of time². The rate-equation is more generally useful when written in a less restricted form; for example:

$$-R_s = -2R_b = \frac{k}{V^2} \cdot a^2b. \quad (2)$$

The system to which this equation applies may be open or closed, but has a constant atomic content, and is assumed to be virtually uniform in composition and temperature. At a given instant it has volume V and contains a, b moles of A, B . $-R_s$, $-R_b$ are the rates of destruction of A, B by the reaction. k has the same significance and value as in equation (1).

In a closed system, $R_s = da/dt$; V may be a function of a, b, t . Equation (2) is then to be integrated accordingly. In a flow-system operating at steady state, V, a, b and R_s are constant, the latter being the difference between the rates of inflow and outflow of A . Other variants may also be encountered.

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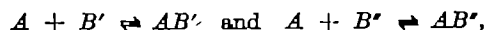
¹ Robb, J. C., *Nature*, **172**, 1055 (1953).

² Denbigh, K. G., *J. App. Chem.*, **1**, 227 (1951).

A Competitive Method of determining Association Constants

THE method described by Benesi and Hildebrand¹ for determining the association constants of charge-transfer complexes involves optical measurements of a series of solutions at or near the wave-length of maximum absorption of the complex. A simple method for determining such constants which avoids these conditions has been devised.

Consider the two interactions:



involving two Lewis bases B' and B'' and a Lewis acid A (or vice versa). An equilibrium constant K may be defined as:

$$K = \frac{[AB]}{([A] - [AB])([B] - [AB])} \quad (1)$$

where $[A]$ and $[B]$ are the initial concentrations of A and B . For simplicity, let $[B'] = [B''] = [B]$, say, then if $[B] \gg [A]$:

$$K' = \frac{[AB]}{[B]([A] - [AB] - [AB'])} \quad (2)$$

$$\text{and } K'' = \frac{[AB]}{[B]([A] - [AB'] - [AB''])} \quad (3)$$

Eliminating $[AB']$ from equations (2) and (3):

$$[AB'] = \frac{K[A][B]}{1 + K[B] + K'[B]}. \quad (4)$$

A wave-length is selected at which the species A, B', B'' and AB' have negligible absorptions, but at which AB' absorbs (preferably at or near the maximum of the charge-transfer spectrum of this species). If the extinction coefficient of the species AB' at this wave-length is ϵ , then the optical density of a solution at this wave-length will be $D = \epsilon[AB']$.

The optical densities of two solutions, one containing A and B' at concentrations $[A]$ and $[B]$, the other containing A, B' and B'' at concentrations $[A], [B]$ and $[B]$, are measured at this wave-length. If D_1 and D_2 are the two optical density readings so obtained, then applying equation (4):

$$\frac{D_1}{D_2} = \frac{1 + K[B]}{1 + K[B] + K'[B]} \quad (5)$$

$$\text{or } K' = \frac{D_1 - D_2}{D_2} \left(K' + \frac{1}{[B]} \right). \quad (6)$$

Knowing K' , K'' may be determined.

Applying the method to the complex of N - n -butylaniline and s -trinitrobenzene by measuring the competition of the former with N - N - N' -tetramethyl p -phenylenediamine in cyclohexane, the following results were obtained:

$$[B] = 0.118 M; [A] \approx 10^{-4} M;$$

$$D_1 = 0.320 \text{ cm}^{-1} \text{ and } D_2 = 0.255 \text{ cm}^{-1} \text{ at } 650 \text{ m}\mu.$$

Using a value of $K = 20.4$ litres/mole for the association constant of N - N - N' -tetramethyl p -phenylenediamine with s -trinitrobenzene in cyclohexane (obtained by the method of Benesi and Hildebrand), a value of the association constant of N - n -butylaniline with s -trinitrobenzene in cyclohexane of 7.4 litres/mole is obtained. The value obtained by the method of Benesi and Hildebrand is 8.2 litres/mole.

R. FOSTER

Dyson Perrins Laboratory,

South Parks Road, Oxford. Oct. 12.

¹ Benesi and Hildebrand, *J. Amer. Chem. Soc.*, **71**, 2703 (1949).

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, February 1

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. W. R. Howard: Presidential Address.

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (in the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. W. Barrett: "Production and Development of Chemicals for the Rubber Industry".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with the ALKEMIC CLUB, in the Physical Chemistry Laboratory, Oxford), at 8.15 p.m.—Mr. A. R. Powell, F.R.S.: "The Platinum Metals".

Tuesday, February 2

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. M. Mary Douglas: "Primitive Medicine among the Lale of the Belgian Congo".*

INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. J. E. Richardson and Mr. W. K. Zaki: "Sedimentation and Fluidization".

ROYAL INSTITUTE (at 21 Albemarle Street, London, W.1), at p.m.—Prof. H. Munro Fox, F.R.S.: "Colour in Animals". (Further lectures on February 9, 16 and 23.)

Wednesday, February 3

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. J. G. Capewell: "The Post-Silurian re-Marine Carboniferous Sedimentary Rocks of the Eastern Side of the English Lake District". Dr. F. W. Anderson and Dr. V. Wilson: "The Occurrence of Algal Beds in British Paleozoic and Mesozoic Rocks".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate Station, London, S.W.1), at 6.45 p.m.—Internal Combustion Engine Group Discussion: "The Extent to which the Gas Turbine may Supplant or Supplement the Piston Engine in the Next Ten or Twenty Years".

Thursday, February 4

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. J. Maynard Smith: "Mendel, Michurian and Hybrid Vigour".*

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m. and 7.30 p.m.—Symposium on "Kinetics and Mechanism of Inorganic Reactions in Solution. A Survey of Recent Work".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. J. C. Bevington, Mr. G. M. Guzman, and Prof. F. W. Melville, F.R.S.: "Self-branching in the Polymerization of styrene and of Vinyl Acetate"; Mr. P. Alexander, Mr. A. Charnishy, and Mr. M. Bess: "The Degradation of Solid Polymethylmethacrylate by Ionizing Radiation".

LINEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. R. Melville: "Plant Hunting Across Australia, 1953-1954".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. G. Dawson, Mr. L. L. Hall, Mr. K. G. Hodgson, Mr. R. A. Meers, and Mr. J. H. H. Martin: "The Manchester-Kirk of Shotts Television Radio Relay System".

ROYAL METEOROLOGICAL SOCIETY (in the Conference Hall, County Hall, Westminster Bridge, London, S.E.1), at 5.30 p.m.—Mr. J. S. Sawyer: "Weather Forecasting".*

UNIVERSITY OF LONDON (at the School of Pharmacy, 17 Bloomsbury Square, London, W.C.1), at 5.30 p.m.—Prof. J. H. Gaddum, F.R.S.: "Discoveries in Pharmacology".* (Further Lecture on February 5.)

UNIVERSITY OF LONDON (at Senate House, London, W.C.1), at 8.0 p.m.—Air Marshal Sir Harold Whittingham: "Medical Science and Problems of Flying".* (Further Lecture on February 11.)

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. F. Bergal: "Some Chemical Aspects of Abnormal Growth".* (Further Lecture on February 9.)

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Mr. R. W. Douglas: "Germanium and Silicon".

INSTITUTE OF WELDING, NORTH LONDON BRANCH (at Manson House, Orford Place, London, W.1), at 7 p.m.—Dr. R. Week: "Avoiding slag in Welded Structures".*

Friday, February 5

SOCIETY OF COMBUSTION CHEMISTS OF GREAT BRITAIN (at the Royal Society of Tropical Medicine and Hygiene, 25 Portland Place, London, W.1), at 7 p.m.—Prof. W. D. Wright: "Colour and Colour Vision".

POLISH CULTURAL INSTITUTE (at 81 Portland Place, London, W.1), at 8 p.m.—Dr. M. J. Beaton: "The Copernican Controversy and its significance for Modern Science".*

ROYAL INSTITUTE (at 21 Albemarle Street, London, W.1), at p.m.—Prof. M. Postan: "Medieval Science and Technology".

Saturday, February 6

LONDON COUNTY COUNCIL (at the Hornman Museum, London Road, Great Hill, London, S.E.23), at 3.30 p.m.—Mr. M. Freedman: "Death and Marriage Among Chinese in Singapore".*

BRITISH INTERPLANETARY SOCIETY (in the York Hall, Caxton Hall, Westminster, London, S.W.1), at 6 p.m.—Mr. K. W. Gatlend: "Progress Towards Astronautics".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned.

ASSISTANT LECTURER IN CHEMISTRY, at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (February 6).

EXPERIMENTAL OFFICER (Physicist or Metallurgist) (with at least H.S.C. (science), or equivalent, but degree in metallurgy or physics may be an advantage), for work on X-ray diffraction in the METALLURGY DIVISION—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berks, quoting 2/103/4 (February 6).

HEAD (graduate in science, engineering or mathematics, and with suitable experience in the textile industry) OF THE TEXTILE DEPARTMENT, Bolton Technical College—Chief Education Officer, Education Office, Nelson Square, Bolton (February 6).

HEAD (with honours degree in chemistry, and textile experience, preferably in the hosiery trade) OF THE CHEMISTRY DEPARTMENT—The Secretary, Hosiery and Allied Trades Research Association, 4 First Avenue, Sherwood Rise, Nottingham (February 6).

PHYSICISTS, Scientific Officer grade (with first- or second-class honours degree, or equivalent), or **Experimental Officer grade** (with H.S.C. (science), or equivalent), in Ministry of Supply Research and Development Establishments, to apply their knowledge to problems from many fields, including aerodynamics and aircraft structures, aircraft instruments, armaments, electronic circuits, radio and radar—The Ministry of Labour and National Service, Technical and Scientific Register (R), 26 King Street, London, S.W.1, quoting A1/54A (February 6).

SENIOR LECTURER (preferably with knowledge of applied chemistry) IN INORGANIC CHEMISTRY—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (February 6).

LECTURER (graduate in chemical engineering, or graduate in chemistry, with postgraduate training and/or experience in chemical engineering) IN CHEMICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (February 8).

FIRST ASSISTANT STATION CHEMIST (preferably with university degree or A.R.I.C.), at Barton Generating Station, Manchester—The Establishments Officer, British Electricity House, 835 Wilmslow Road, Manchester 20, quoting "Vacancy No. 6-54" (February 13).

SCIENTISTS, Grade II or III (with first- or second-class honours degree, or equivalent, in engineering, mathematics or physics, and some experience in field or laboratory research) IN THE FIELD INVESTIGATION GROUP, to carry out field work at collieries—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting IT/7/29 (February 13).

ANALYTICAL CHEMIST IN THE DEPARTMENT OF AGRICULTURAL CHEMISTRY—The Registrar, Wye College, near Ashford, Kent (February 15).

CHAIR OF BOTANY—The Registrar, University College, Singleton Park, Swansea (February 16).

MAY AND BAKER RESEARCH FELLOW (with qualifications in plant pathology, and some postgraduate research experience) to undertake research work under the direction of the Professor of Agricultural Chemistry, on fungicides and systemic fungicides (including field trials)—The Registrar, Wye College, near Ashford, Kent (February 15).

ASSISTANT LECTURER IN APPLIED MATHEMATICS—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (February 20).

CHAIR OF ELECTRICAL ENGINEERING—The Registrar, The University, Nottingham (February 20).

LECTURER IN BACTERIOLOGY, and an **ASSISTANT LECTURER IN CHEMISTRY**—The Registrar, Trinity College, Dublin (February 20).

PRINCIPAL SCIENTIFIC OFFICER (with an honours degree in science or civil engineering, and a knowledge of applied mathematics and physics, and preferably with experience in the application of soil mechanics to civil engineering design and construction) in the Air Ministry, for work on soil mechanics at Church Lawford, Warwickshire—The Ministry of Labour and National Service, Technical and Scientific Register (R), 26 King Street, London, S.W.1, quoting R.41/54A (February 20).

ASSISTANT NUTRITIONIST (non-medical) (with B.Sc. in biological sciences, and some teaching and research experience), for evaluating dietaries, analysing field data, abstracting papers, preparing reports and assisting in teaching tropical nutrition and dietetics—The Director, Applied Nutrition Unit, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1 (February 22).

READER IN MORBID ANATOMY, tenable at London Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (February 22).

HEAD (with good honours degree, and teaching experience) OF THE MATHEMATICAL DEPARTMENT—The Registrar, The Royal Belfast Academical Institution, Belfast (February 23).

LECTURER IN PSYCHOLOGY at New England University College, Armadale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Armadale, March 1).

ROBERT BLAIR FELLOWSHIP tenable for one year of advanced study or research abroad in Applied Science or Technology—The Education Officer (EO/H/1/2), County Hall, London, S.E.1 (March 1).

LECTURER IN THE DEPARTMENT OF CHEMISTRY, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Wellington March 5).

CHAIR OF GEOGRAPHY—The Registrar, University College of Leicester, Leicester (March 6).

READER (with high academic qualifications, and research experience in theoretical physics, preferably in quantum theory) IN THEORETICAL PHYSICS, at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, March 22).

TURNER AND NEWALL RESEARCH FELLOWSHIP IN ENGINEERING, INORGANIC CHEMISTRY OR PHYSICS, or other allied science—The Registrar, The University, Leeds 2 (April 21).

ASSISTANT DIRECTOR, to take charge of a team of chemists, physical chemists, physicists and mathematicians, engaged on a comprehensive scientific study of the physical and chemical properties of rayon and synthetic fibres, and problems associated with the application of these fibres—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

BRITISH RUBBER PRODUCERS' RESEARCH FELLOW (with a good honours degree in engineering or physics, and industrial or research experience) for research into the mechanical properties of rubber—The Registrar, The University, Nottingham.

ENGINEERS, PHYSICIANS, PHYSICAL CHEMISTS AND METALLURGISTS (Senior Scientific Officer and Scientific Officer grade) (with an appropriate first- or second-class honours degree or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.246/82A/T7.

EXTENSION LECTURER (with high academic qualifications in pure science, preferably in physics or chemistry) IN SCIENCE, to lecture at an advanced level to science graduates in industry, etc., principally in Cumberland—The Director of Extra-Mural Studies, King's College, Joseph Cowen House, 153 Barras Bridge, Newcastle-upon-Tyne 1.

LECTURER (with a good honours degree in applied or pure science, and research and industrial experience) IN MECHANICAL ENGINEERING—The Registrar, The University, Nottingham.

MATHEMATICS MASTER (with high honours degree)—The Head Master, Lancing College, Shoreham-by-Sea, Sussex.

METALLURGIST (with a degree in metallurgy or equivalent qualification, and preferably with previous industrial experience) for work entailing the application of research results in industrial practice—The Secretary, British Non-ferrous Metals Research Association, 50-51 Ruxton Street, London, N.W.1.

MINING GEOLOGIST (with B.Sc. degree with honours in mining geology) in the Colonial Geological Survey Service, Sierra Leone, for duties which include search for new mineral deposits, mapping, petrology and mineralogy of known mineral deposits, geological mapping, geophysical prospecting by resistivity and magnetometry—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDB.105/15/02.

PHYSICIST (with first- or second-class honours degree in an appropriate scientific subject, of a United Kingdom or Commonwealth University, or an equivalent qualification) IN THE COLONIAL INVENTORIES RESEARCH UNIT, at the Ministry of Supply Chemical Defence Experimental Establishment, Porton, near Salisbury, to undertake research work in connection with the application of chemical formulations for the control of pests of public health and agricultural importance—The Under-Secretary of State, Research Department (8.610), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

PHYSICISTS (with good honours degree, and some experience or training in research, not necessarily in textile research), for work on textile problems—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, near Manchester.

SCIENTIFIC OFFICERS (with first- or second-class honours degree in a suitable subject, or equivalent qualifications) in the Department of Scientific and Industrial Research, Mechanical Engineering Research Laboratory, Bant Kilbride; **MATHEMATICIAN OR MECHANICAL ENGINEER**, for work on stress distribution and fatigue problems (Ref. C.16/54A); **ELECTRICAL ENGINEER OR PHYSICIST**, for work on application of noise control techniques to the suppression of noise in machinery (Ref. D.30/54A); **PHYSICIST OR PHYSICAL CHEMIST** (with sound knowledge of classical thermodynamics) for preparation of thermodynamic tables (Ref. A.11/54A); **ENGINEER OR PHYSICIST**, for investigation into the fundamental mechanism of plastic deformation of materials (Ref. A.12/54A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate Ref. No.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Education, Religion, Learning and Research (An Inaugural Lecture). By the Rev. Prof. J. Burnaby. Pp. 26. (Cambridge: At the University Press, 1953.) 2s. 6d. net. [161]

General Register Office. Census 1951, England and Wales. County Report London. Pp. 1+90. (London: H.M. Stationery Office, 1953.) 22s. 6d. net. [161]

Department of Agriculture for Scotland. Hill Farm Research. Second Report. (Scottish Hill Farm Research Committee.) Pp. 106. (Edinburgh: H.M. Stationery Office, 1953.) 3s. 6d. net. [171]

Diseases and Pests on Horticultural Planting Material. A Guide to Their Recognition. Pp. iv+38+30 plates. (London: H.M. Stationery Office, 1953.) 6s. net. [181]

Royal Society of Chemistry. Lectures, Monographs and Reports, 1953. No. 4: Commercial Aspects of the Chemical Industry. By John Rogers. (Thirteenth B. M. Ghosh Memorial Lecture.) Pp. 11+11. (London: Royal Institute of Chemistry, 1953.) 2s. net. [181]

Spheroidal Graphite Cast Iron: Engineering Properties and Applications. Pp. 52 (8 plates). (London: The Mond Nickel Co., Ltd., 1953.) [181]

Science Club. Number 1 (Autumn, 1953). Pp. 8. (Leicester Science Club, 47 Edward Avenue, 1953.) 2s. [181]

Southern Regional Council for Further Education. Sixth Annual Report, October 1953. Pp. 20. (Reading: Southern Regional Council for Further Education, 1953.) [141]

Marine Biological Station, Port Erin, Isle of Man. Annual Report for 1952 (No. 65). Pp. 32+1 plate. (Liverpool: University Press of Liverpool, 1953.) 3s. [241]

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations. Season 1952-53. Aden Protectorate: Abyan Cotton Experiment Station. By R. R. Anson. Pp. 8. 9d. Kenya Nyanza Province. By M. S. Hassie. Pp. 7. 9d. Uganda: Cotton Research Station, Namulonge. Pp. 34. 9d. (London: Empire Cotton Growing Corporation, 1953.) [241]

Department of Scientific and Industrial Research. Road Research Laboratory. Road Note No. 16. Bituminous Surfings made by the Wet-Aggregate (Hydrated Lime) Process. Pp. 20+1 plate. (London: H.M. Stationery Office, 1953.) 1s. net. [241]

Department of Scientific and Industrial Research. Memoirs of the Geological Survey of Great Britain: England and Wales. Geology of the Country between Bradford and Skipton. (One-Inch Geological Sheet 69, New Series.) By J. V. Stephens, Dr. G. H. Mitchell and Wilfrid Edwards. With contributions by Dr. C. J. Stubblefield and Dr. K. C. Dunham. Pp. vii+180+9 plates. (London: H.M. Stationery Office, 1953.) 25s. net. [241]

Other Countries

Indian Council of Medical Research. Technical Report of the Scientific Advisory Board for the Year 1952. Pp. xii+287. (New Delhi: Indian Council of Medical Research, 1953.) 1 rupee. [16]

Norsk Polarinstitutt. Meddelelse Nr. 69: Norsk skavangelsk En fortællelse over litteratur. Ved Adolf Hoel. Pp. 25. 2.50 kroner. Nr. 70: Planter Collected in Vestspitsbergen in the Summer of 1953. By Asbjørn Hagen. Pp. 14+1 plate. 2.00 kroner. Nr. 71: Comglomerates Formed in Situ on the Gipsbuk Coastal Plain, Vestspitsbergen. By Rolf W. Feyling-Hanssen. Pp. 9+1 plate. 2.50 kroner. (Oslo: I Kommissjon Hos Jacen Dybwad, 1953.) [161]

Norsk Polarinstitutt. Skrifter No. 97: The Downtonian and Devonian Vertebrates of Spitzbergen. IX. Morphological and Systematic Studies of the Spitzbergen Cephalopoda. By G. Wängö (Results of Th. Vogt's Expedition 1928, and the English-Norwegian Swedish Expedition 1938.) Vol. A. Text: Pp. 616. Vol. B. Plates: Pp. 42+118 plates. (Oslo: I Kommissjon Hos Jacen Dybwad, 1952.) 2 volumes 75 kroner. [161]

Koninklijk Nederlands Meteorologisch Instituut. (108.) Seismic Records at De Bilt. No. 35, 1948. Pp. vii+34. (Gravenhage: De Vereniging Bij Het Staatsdrukkerij Uitgeverijbedrijf, 1953.) 1 florin. [161]

Koninklijk Nederlands Meteorologisch Instituut. Mededelingen en Verhandelingen No. 58: Toepassing Van Statistische Methoden in de Klimatologie. By Dr. H. van der Bijl. Pp. x+198. (Gravenhage: Staatsdrukkerij- en Uitgeverijbedrijf, 1952.) 7.60 florins. [161]

Koninklijk Nederlands Meteorologisch Instituut. Upper Air Data. No. 35 1950. Pp. 130. 12 florins. Upper Air Data, No. 36. 1951. Pp. 120. 12 florins. (De Bilt: Koninklijk Nederlands Meteorologisch Instituut, 1952.) [161]

Göteborgs Kungl. Vetenskaps- och Vitterhets-Samhälle. Report of the Swedish Deep-Sea Expedition 1947-1948. Vol. 3, Physics and Chemistry. Fasc. 2. Edited by Hans Pettersson. Pp. ii+78-126+5 (Appendix). (Göteborg: Elanders Boktryckeri Aktiebolag, 1953.) 20 kroner. [161]

Institut Royal Meteorologique de Belgique. Contributions No. 8: La mesure de la pression atmosphérique. Par R. Sneyers. Pp. 12. No. 10: A propos du "Ras de Marée" du 1er février 1953. Par L. Poncet. Pp. 4. No. 11: La tempête et le débordement de la mer du 1er février 1953. Par R. Sneyers. Pp. 12. (Uccle-Bruxelles: Institut Royal Meteorologique de Belgique, 1953.) [171]

Explorers of the Pacific: European and American Discoveries I. Polynesia. By Peter H. Buck. (Bernice P. Bishop Museum Special Publication 43.) Pp. viii+120 (Honolulu: Bernice P. Bishop Museum, 1953.) 1.75 dollars. [171]

Food and Agriculture Organization of the United Nations. Plan Production Branch: Agriculture Division. Working Party on Mediterranean Pasture and Fodder Development, Algiers, 28 Apr. to 2 May 1953. Pp. 46. (Rome: Food and Agriculture Organization of the United Nations, 1953.) [171]

Canada. Department of Mines and Technical Surveys. Dominion Observatories. Publications of the Dominion Observatory, Ottawa. Vol. 14: Bibliography of Seismology, No. 12, Items 7053-8112 (July-December, 1953.) By W. G. Milne and W. H. T. Smith. Pp. ii+235-256. (Ottawa: Queen's Printer, 1953.) [171]

U.S. Department of Commerce Weather Bureau. Technical Paper No. 22: Wind Patterns over Lower Lake Mead. (Prepared by the Hydrologic Services Division.) Pp. 40. 25 cents. Technical Paper No. 24: Rainfall Intensities for Local Drainage Design in the United States. For durations of 5 to 240 minutes and 2, 5, and 10 Year Return Periods. Part 1: West of the 115th Meridian. (Prepared by Cooperative Studies Section: Hydrologic Services Division.) Pp. 20. 20 cents. (Washington: Government Printing Office, 1953.) [171]

Indian Central Cotton Committee: Technological Laboratory. Technological Reports on Standard Indian Cotton, 1952. (Technological Bulletin, Series A, No. 82.) Pp. iv+98. (Bombay: Vakil and Sons, Ltd., 1953.) 2 rupees. [181]

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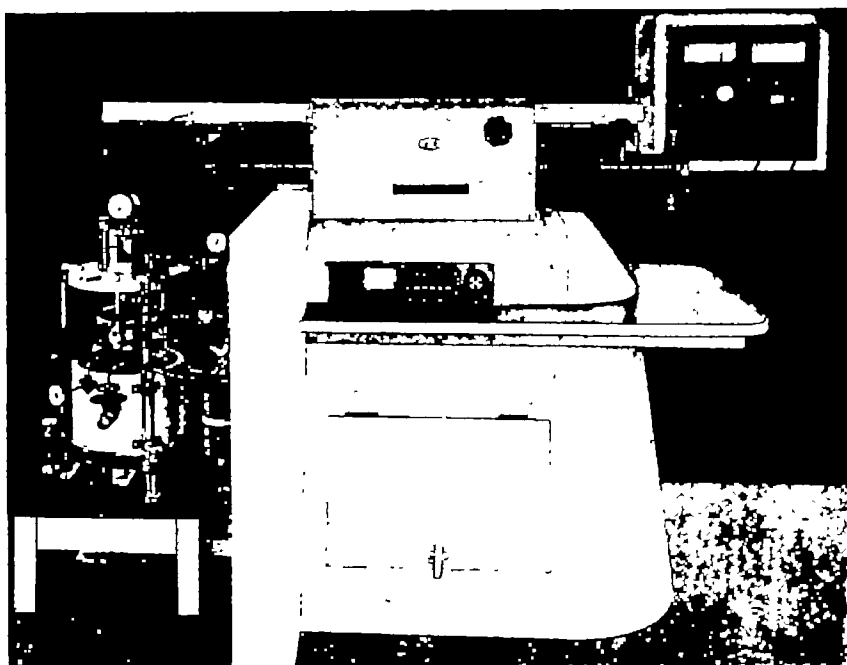
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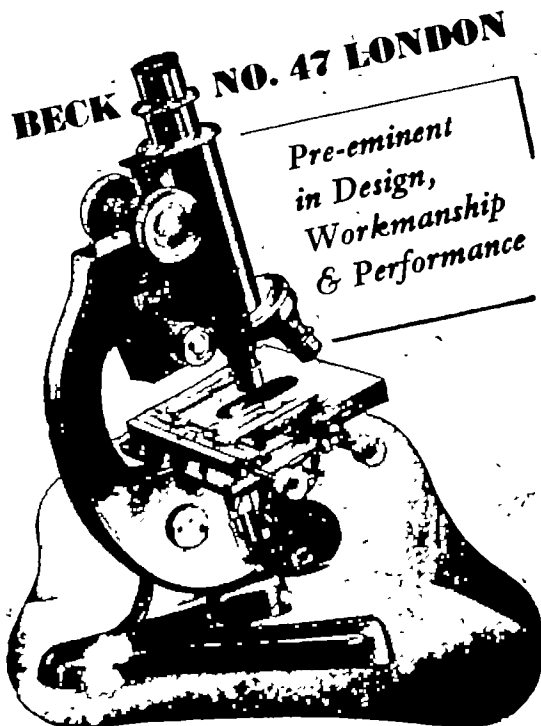
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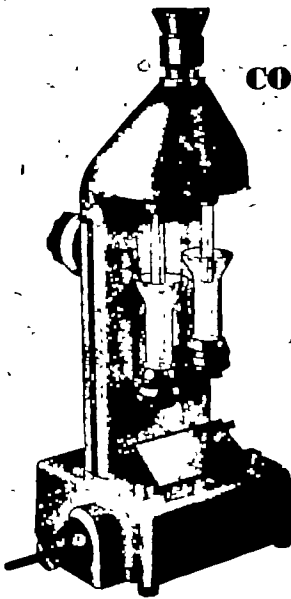
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SATURDAY, FEBRUARY 6, 1954

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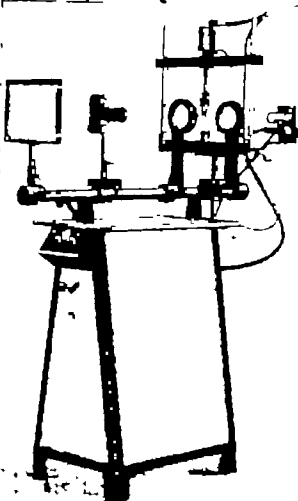
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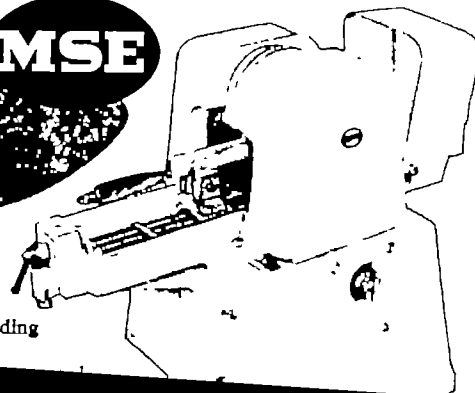
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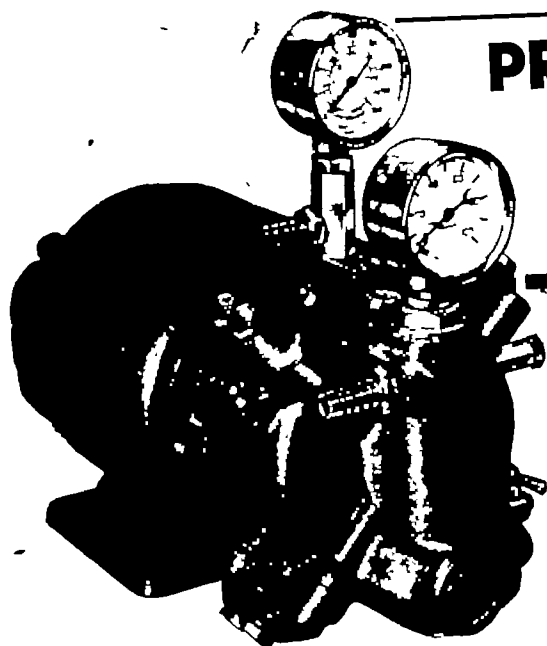
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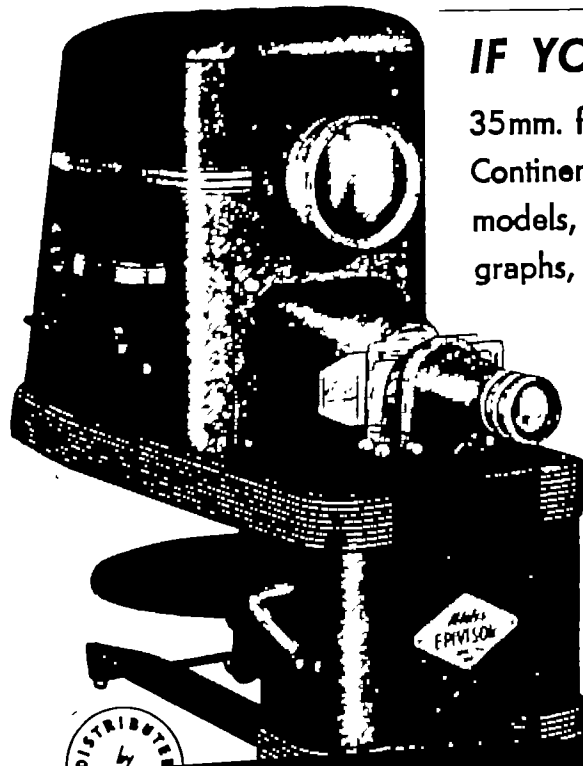
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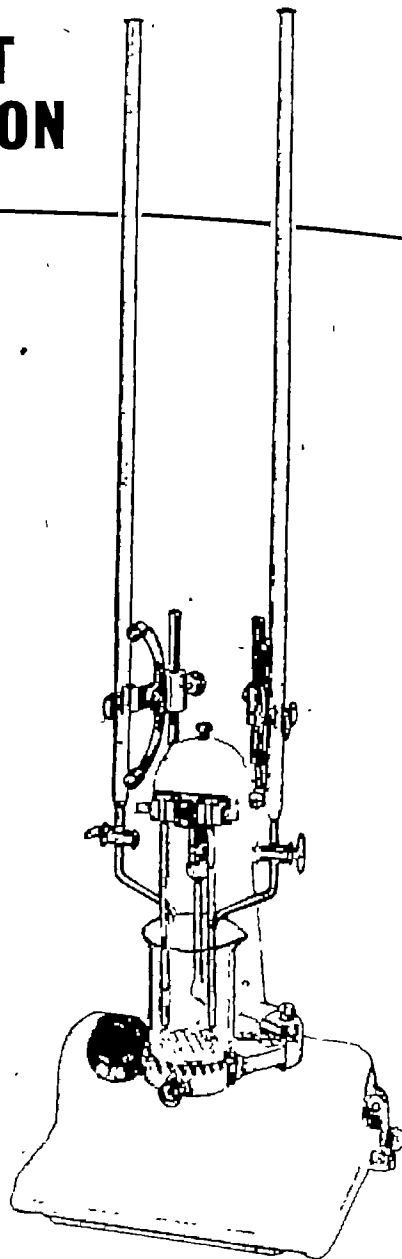
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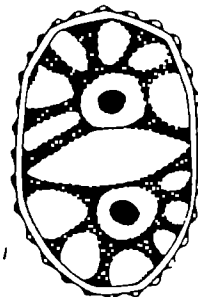
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PROTECTION OF BIRDS IN BRITAIN

IN Great Britain there are two main sets of laws dealing with the protection of birds—the Game Acts and the Wild Birds Protection Acts.

In contrast to some other European countries, where game birds may include thrushes, skylarks and even grebes, game birds in England and Wales are strictly defined in the main Game Act of 1831, which designates black game, bustard, grouse, partridge and pheasant under this heading, and lays down the close times which are to be observed for these species. In addition, game birds are also subject to strict controls regarding sale, possession, trespass and so on, and can only be shot by those possessing a game certificate, whereas for wild birds a gun licence only is necessary. Duck, geese and waders, although shot for sport, are not designated as game and are covered by the Wild Birds Protection Acts. Woodcock, snipe, quail and landrail, though not designated as game in the Act of 1831, and the close times of which are regulated by the Wild Birds Protection Acts, are, however, included in some of the provisions of the Game Acts, and it is necessary to possess a game certificate to shoot them.

The Wild Birds Protection Act of 1880 superseded all previous Acts for the general protection of birds and formed the main basis of legislation. In the ensuing fifty years, thirteen further Acts for the protection of birds were made law; further, in the course of time, 260 local orders have been added making various alterations regarding close times, etc. The Acts of Parliament have to be read together with the local order to ascertain what amount of protection any particular bird may have—and, in short, the law is so complicated and unwieldy that few people understand it, much less enforce it.

The need for new legislation has been recognised for nearly half a century. So long ago as 1914, a departmental committee was appointed by the Home Secretary under the chairmanship of the Right Hon. E. S. Montagu, M.P., to make recommendations for clearing up the confusion of the bird protection laws. This committee made its report in 1919; but since that date, six further Acts have been passed. Various societies and individuals have sought to introduce new measures to end the existing state of confusion, and committees after committees of ornithologists and other experts have spent much time and trouble in drawing up reports to this end. But the years have passed without any result from their labours.

After the War the Home Office Wild Birds Advisory Committee was reconstituted under the chairmanship of the Earl of Ilchester and continued the work of preparing a single Bill for the Protection of Birds, which would incorporate and simplify all necessary provisions contained in existing legislation with the addition of further provisions to meet modern requirements. Concurrently, a Scottish Wild Birds Advisory Committee worked on the same lines, and the agreed proposals of the two Committees form the main provisions of two Bills placed before Parlia-

ment, one in the House of Lords, sponsored by Viscount Templewood, which received its second reading on November 11, 1953, and a private member's Bill in the Commons, sponsored by Lady Tweedsmuir, which received its second reading on December 4, 1953.

Under both these Bills, no less than fifteen complete Acts of Parliament and also parts of several more are repealed, which gives some idea of the much greater simplification and clarity which should result.

The two Bills, being based on the proposals made by the Advisory Committees, are very similar and only vary in certain details. The fundamental provision is the change to the modern conception of affording protection throughout the whole year to all birds, excepting those causing damage, which may be killed at any time, and also those which are termed 'sporting birds' and may be killed during certain periods of the year only. The principle of departing from the old system of making long lists of birds which are to receive protection has already been adopted by other countries, notably by Northern Ireland in 1931, and forms the basis of the International Convention for the Protection of Birds which was signed *ad referendum* by the representatives of twelve European countries in Paris in 1950 (*Nature*, 167, 173; 1951). Under the old system, if a rare bird appeared in Great Britain it was not legally protected unless it happened to be mentioned in a list, either statutory or local; but under the new provision all rarities will be automatically provided for under the omnibus protection accorded to all birds.

Four schedules are added to the Bills. The first contains the very rare species, the killing or taking of which at any time is subjected to increased penalties. A second part of this same schedule contains a list of species considered as sporting birds but which, though not uncommon, rarely breed in Great Britain. They are, therefore, during the breeding season, given the additional safeguard of increased penalties, though they may legitimately be killed at other times. The special penalties also apply to the taking of eggs of all birds in this schedule. The second schedule contains a list of birds which are considered harmful in one way or another and which may be killed at any time. In order to avoid the wholesale destruction of such birds, the power to destroy them is limited to owners and occupiers of land, and certain statutory bodies, or persons authorized by them. The third schedule contains a list of the sporting birds which may be shot outside a specified close season, and the fourth schedule consists of birds which may not be sold alive, unless they are close-ringed specimens bred in captivity. This last schedule is a re-enactment of the Bird Protection Act 1933, which was designed to stop the traffic in British wild birds.

In the past, legislation with regard to bird protection has proved far too inelastic, and with rapidly changing conditions this state of affairs is unworkable. A common species may become scarce; or a species which is quite innocuous in small numbers may become the reverse if there is a large increase.

In the present Bills, allowance is made for such changes by investing the Secretary of State with the power to make any necessary adjustments to the schedules. Exceptions to the provisions of the Bills may also be made, by means of licences, for science, education and so on; and agriculture, fisheries and other interests are safeguarded. Statutory committees on wild birds to advise the Secretaries of State for England and Scotland are to be appointed.

In the past, certain methods of taking and killing birds have been prohibited, mainly on account of the cruelty involved, and these prohibitions have been incorporated in the Bills. To these have been added certain other methods which are prohibited, not so much on account of any cruelty involved, but to avoid undue slaughter of birds in large numbers and to make the odds brought about by modern methods of destruction less heavy against the quarry.

The need for an international point of view in bird protection is now generally recognized, and this is provided for in the new Bills by restrictions on the import of certain birds and eggs, and power is given to the Secretary of State to prohibit the import of any bird or egg for the whole or part of a year. In this way international co-operation with any country which is endeavouring to prevent the exploitation of any species can be achieved; a precedent for this was made in the Protection of Quails Act, 1937, which prohibited the import of live quails during certain months, a measure in support of the action taken by the Egyptian Government in prohibiting the export during the same period.

It is generally accepted that the commercialization of a species is its greatest danger, and to this end restrictions are placed on the sale of certain birds, alive or dead, and the sale of eggs of birds which have nested in the British Isles (those of certain gulls only excepted).

The question of the protection of wild birds' eggs is one of great difficulty. In the International Convention for the Protection of Birds, the general policy of according the same protection to eggs as to birds themselves is followed, subject to certain exceptions, and this method has been adopted with success in other countries, including Australia. The Wild Birds Advisory Committee, on the whole, also took this view; but a very decided opposite opinion has been voiced by many people, including the Government spokesman, the contention being that it is highly undesirable to create a criminal offence in a young boy taking a common bird's egg. That this state of affairs already exists in a large number of counties, in some of which practically every British nesting bird's egg is protected by county order, does not alter this view. This difficult question has been dealt with in different ways in the two Houses; in the House of Lords' Bill, only eggs of the rare birds (Schedule 1) are protected by statute, but power is given to the Secretary of State to prohibit by Order, affecting the whole or part of Great Britain, the taking or destruction of the eggs of any wild bird specified. This maintains the present situation so far as eggs are concerned, and retains the long local lists which it is so desirable to eliminate.

In the Commons, the other approach has been taken of according protection to the eggs of all wild birds except for those of the harmful birds (Schedule 2) or "of any other common wild birds which the Secretary of State may by Order made with respect to the whole or any specified part of Great Britain prescribe for the purposes of this paragraph". This again is not a simple solution, for a list of birds' eggs which may be taken is, in the opinion of some people, a direct incentive to plunder birds' nests; moreover, to draw up such a list would be a far from easy task.

In the Bills, power to establish bird sanctuaries is given to provide for such areas which are not covered by the National Parks Act of 1949, enforcement of the law is made simpler and penalties for infringement are increased in accordance with present-day standards.

The Game Laws are in no way affected by the Bills except in so far as they mention the landrail and quail. These two species, having become very scarce, are included in the first schedule of the new Bills; the relevant passages regarding the shooting of these birds in the Game Acts 1831, 1832 and 1860 are therefore repealed.

Legislation in Great Britain for the protection of birds, as has been said, has become involved and cumbersome, and a revision was overdue. The present Bills, while not wholly satisfactory, seem to provide, in their different ways, for the protection of birds, and are in line with international feeling on the subject; it is to be hoped that there will be no undue delay in one or other reaching the Statute Book.

THE CASE FOR NATURAL SELECTION

Evolution In Action

Based on the Patten Foundation Lectures delivered at Indiana University in 1951. By Dr. Julian Huxley. Pp. 160. (London: Chatto and Windus, 1953.) 9s. 6d. net.

IN a very short time biologists, all over the world, will celebrate the centenary of "The Origin of Species by means of Natural Selection". There may be some heart-searching; there will certainly be a great deal of discussion.

Darwinian orthodoxy demands implicit faith in the efficacy of natural selection operating on chance mutations. Subscribe to this and all doubts and hesitations disappear; question it and be forever lost. The case for orthodoxy can seldom have been stated with greater cogency and enthusiasm than by Dr. Julian Huxley in "Evolution in Action". A few readers, perhaps rather pagan in their outlook, may think it a little strange that, if the case is quite so strong as they are asked to believe, it should still be necessary to argue the merits of natural selection with almost evangelistic vigour.

On one point all biologists are agreed: the basic concept of organic evolution has, for a century, stood unrivalled as a contribution to biological thought. As a working hypothesis it opened up and exploited vast new fields of palaeontological, anatomical and embryological inquiry. The status of natural selection is not quite so high. True, it is the only theory we

have; but when judged as a working hypothesis it is disappointing to find so little advance in a hundred years. What new facts have been brought to light? How far can it be shown to have elaborated the pageantry of animal life since 1859? A century is a fantastically short period of cosmic time, and all sorts of queer, exciting and improbable things may happen in five hundred million years; so, if we accept 'possibility' as a basis for scientific thought, why worry? Dr. Huxley admits quite frankly: "No one would bet on anything so improbable happening; and yet it *has* happened. It has happened thanks to the workings of Natural Selection and the properties of living substance which make Natural Selection inevitable". What more can be said, except possibly to suggest that there may be a slight difference between something that 'has happened' and one which 'may have happened'. No amount of argument, or clever epigram, can disguise the inherent improbability of orthodox theory; but most biologists feel it is better to think in terms of improbable events than not to think at all; there will always be a few who feel in their bones a sneaking sympathy with Samuel Butler's scepticism: "... there must have been a little cheating somewhere with these accidental variations [mutations] before the eagle could have become so great a winner". How far the heathen will be converted by Dr. Huxley is difficult to say.

The theory of natural selection implies the survival of organisms possessing functional advantages over their predecessors or rivals. Strange as it may seem, one immediate effect of the "Origin" was a marked recession in the study of animal function. There was, and still is, a tendency for morphologists to ascribe to organs and structures functional significance for which there was, or is, little observational evidence. In this respect "Evolution in Action" is by no means guiltless; it goes a considerable way beyond the physiological facts. Is Dr. Huxley quite sure that the loss of the lateral digits by the ancestors of the horse gave them an "additional turn of speed"? And, is he certain that the parallel between increasing complexity of anatomical structure (so clearly displayed throughout vertebrate evolution) and increasing complexity or versatility of behaviour is quite so obvious as he suggests? In what ways is the behaviour of a frog, a lizard, or even a sheep, an 'advance' on that of a stickleback? What about the hoary old story of snakes walking by their ribs?

To lay readers the more exciting part of "Evolution in Action" deals with the position of man in relationship to the rest of the animal world. To Dr. Huxley, man is an organism in a class apart from all others. In many ways man is more distinguished; but most readers will be sorry to read that "the human species to-day is burdened with many more deleterious mutant genes than can possibly exist in any species of wild creature". It seems a great pity that natural selection should have met its Waterloo just when it was most needed.

In the jungles of the past Nature guards her secrets with particular care, and it is a brave man who ventures far from the recognized tracks; it is so much easier to sit and criticize more adventurous spirits. Dr. Huxley's aim is not to comfort the despondent but to hit the dragons of Improbability stoutly on the nose and to give the world "a real feeling of the unity and sweep of evolution... as a self-transforming process... building its future by transcending its past". He has succeeded.

J. GRAY

CARBOHYDRATE CHEMISTRY

Advances in Carbohydrate Chemistry

Edited by Claude S. Hudson, Melville L. Wolfrom, Sidney M. Cantor. Vol. 7. Pp. ix+370. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1952.) 7.50 dollars.

SINCE the first volume of "Advances in Carbohydrate Chemistry" was published in 1945, this series has established itself as indispensable both to those who work in this field and to those workers in other fields who wish to be well informed about sugar chemistry. The present volume maintains the high standard set by earlier volumes of the series. It contains eight articles, five from Britain, two from the United States and one from Germany.

The first of the articles, "The Methyl Ethers of the Aldopentoses and of Rhamnose and Fucose", contributed by R. A. Laidlaw and (the late) E. G. V. Percival, continues the series on the methyl ethers of the sugars started in earlier volumes. Methylation remains the backbone of structural studies in carbohydrate chemistry; this authoritative article will be of particular interest to those engaged in structural studies of the naturally occurring pentoses and of plant gums and mucilages.

The second article, "1,6-Anhydrohexofuranoses, a New Class of Hexosanes", by R. J. Dimler, concerns two compounds, β -glucosan $<1,4>\beta<1,6>$ and β -galactosan $<1,4>\alpha<1,6>$, which are of considerable interest in that they contain a 1,2-glycol system which is not attacked by sodium metaperiodate. This observation is important in view of the widespread use of and increasing dependence on this reagent to detect 1,2-glycol systems; but I am inclined to the opinion that the article would have been more valuable had it been delayed until work designed to test some of the theories advanced to explain this resistance to oxidation had been completed.

The next two articles concern the ketoses. C. P. Barry and J. Honeyman review "Fructose and its Derivatives", and J. V. Karabinos reviews "Psicose, Sorbose and Tagatose". Both articles give excellent accounts of their subjects, although the addition of a discussion of the fructose phosphates, especially of fructose 1,6-diphosphate, would have been welcome in view of their biochemical importance. No mention is made of the tagatose 6-phosphate described towards the end of 1949 by Totton and Lardy¹. Since Dr. Karabinos's review contains only two references (probably added in proof) to papers appearing at a date later than 1949, it is probable that this publication of Totton and Lardy appeared after the review was completed. If this is so, then the delay between the completion of the article and its publication is considerable and strengthens my opinion that all articles of this type should bear the date of receipt of the manuscript by the editors.

The fifth article, "Acetals and Ketals of the Tetritols, Pentitols and Hexitols", by S. A. Barker and E. J. Bourne, is a valuable account of the preparation and properties of these compounds and includes an interesting discussion of the most probable manner in which a given carbonyl compound would condense with a given polyhydric alcohol. The sixth article, "The Glycols", by B. Helferich, has been translated by W. Pigman from the original German. The unsaturated sugar derivatives are not as widely known as they might be, and it is to be

hoped that this article on glycols will be followed fairly soon by one on the glycoosanes. "The Chemistry of the 2-Amino Sugars (2-Amino-2-Deoxy-Sugars)" is discussed by A. B. Foster and M. Stacey. Members of this group of compounds are of considerable interest, both intrinsically and as structural components of the mucopolysaccharides.

All these seven articles in the volume give long and apparently exhaustive tables of selected physical constants of derivatives of the compounds under review.

The final article, "The Size and Shape of some Polysaccharide Molecules", by O. T. Greenwood, reviews the application of physical methods to the determination of the molecular weights of polysaccharides other than starch and cellulose and shows the importance of the use of all possible methods of study before hazarding any suggestion as to the structure of any polysaccharide. In this article I found that the editorial policy of the use of expressions of the type $(0.7)10^4$ and $0.7(10)^4$ in place of the more familiar 0.7×10^4 was at first confusing and later irritating.

The articles as a whole are well written. The printing is clear and the paper and binding excellent. A few trivial misprints were noted, among which were four cases of the value for the diffusion constant (D) in the last article being given in terms of 10^7 instead of 10^{-7} . The volume contains comprehensive author and subject indexes; the entries in the latter were compiled using the recently adopted rules of carbohydrate nomenclature², but the articles to which they refer were written before these rules came into force. There is, however, no confusion.

To sum up, the volume is a valuable contribution to the literature and should be in the possession of all who are interested in carbohydrate chemistry.

L. J. HAYNES

¹ Totton, H. L., and Lardy, H. A., *J. Biol. Chem.*, **181**, 701 (1949).
² *J. Chem. Soc.*, 5108 (1952).

CHEMICAL TECHNOLOGY

Encyclopedia of Chemical Technology

Edited by Raymond E. Kirk and Donald F. Othmer. Vol. 4. Cineole to Dextrose; pp. xvi+969. (1949.) Vol. 5. Di- to Explosions; pp. xvi+992. (1950.) Vol. 6. Explosives to Furfural; pp. xvi+1008. (1951.) Vol. 7. Furnaces to Iolite; pp. xvi+982. (1951.) Vol. 8. Ion Exchange to Metal Plating; pp. xvi+944. (1952.) Vol. 9. Metal Surface Treatment to Penicillin; pp. xvi+944. (1952.) Vol. 10. Pentacene to Polymethine Dyes; pp. xvi+976. (1953.) (New York and London: Interscience Publishers, Inc.) 25 dollars or £8 15s. each volume.

A HUNDRED years ago, the chief source of information bearing on chemical technology was Dr. Ure's "Dictionary of Arts, Manufactures and Mines". At the turn of the century Watt's "Dictionary of Chemistry" was available, but for general reference there was not much else. Thorpe's "Dictionary of Applied Chemistry" and Ullmann's "Enzyklopädie der Technischen Chemie" came into use later. The first volume of Thorpe's "Dictionary" had, however, appeared in 1890.

Turning over the pages of Kirk and Othmer's "Encyclopedia of Chemical Technology", of which Vols. 1-10 have now appeared, the tremendous progress of chemical technology during the past fifty

years is strikingly demonstrated. Already there are ten thousand pages up to the letter P, and more is yet to come. The subjects included in this encyclopaedia confirm the statement which is often made that chemistry nourishes the growth of all technology. One only needs to cite at random a few of the headings to separate articles to illustrate this statement—lubrication, furnaces, malaria chemotherapy, metallic coatings, lamp manufacture, eggs. There are, of course, many articles relating to the different branches of chemical industry—fuels, glass, fermentation, explosives and so on. Articles also are to be found on the techniques—instrumentation, electronics, gas analysis, mass spectroscopy and many other such subjects. The various processes proper to chemical engineering—drying, distillation, crystallization, mixing—are treated in an up-to-date way with suitable photographs and diagrams of plant. There will be found articles on different physical and physical-chemical subjects, such as heat transfer, diffusion, dialysis, electrochemistry, etc., which underlie chemical processes and chemical engineering methods. Besides all this, information is provided about individual chemical substances (organic and inorganic), their properties, their use, their methods of preparation or manufacture and the economic aspects relating to their supply. Pharmaceutical products, biochemical preparations, dyes and intermediates (more than a hundred pages), etc., are included. The article dealing with cosmetics, because of the wide variety of products, is even larger than that on iron; the section of the latter dealing with the blast furnace is perhaps rather too compressed, considering the scale of production with which the blast furnace is concerned. By the careful cross-referencing and the grouping of classes of compounds together, for example, hydrocarbons, petroleum products, cyanides, etc., it has been possible for the editors to provide much information without too much repetition and elaboration.

The articles are written by specialists, and the editors have taken trouble to maintain as uniform a treatment as possible and a high standard. Each article is followed by a brief bibliography. The presentation and printing are pleasing. Most of the contributors are working in the United States; many are widely known for their work throughout the world. The information collected in these volumes is a record of the state of chemical technology in the New World rather than the Old, and this is exemplified on turning up the sections on gas—natural gas, manufactured gas and carbonization: manufactured gas has greater relative importance in Britain than in America, and the technology is somewhat different.

The proportion of the world's trade in chemicals at the present time is nearly as great in the United States as in the whole of the rest of the world, and the turnover has increased at a much greater rate in recent years than in Britain; the rate of increase is greater also in Switzerland. The installation of refineries in Britain and development of other processes may help to widen the basis of chemical industry in this country. Nevertheless, it is comforting that penicillin, polythene and paludrin, to mention three new products under the letter 'P' alone, have their origin in British laboratories.

There are useful articles on such subjects as literature, nomenclature, dimensional analysis, presentation of data, chemical economics, etc. In the remarkably complete article on chemical literature,

there is, however, little mention of the importance of literary style, though in this respect the articles in the encyclopaedia are commendably well presented. The use of unnecessary technical terms is always a temptation, and an expression such as "the armamentarium of gas analysis" is not very elegant. I have found few misprints and few mistakes. In so large a field to be covered there are sure to be faults to find; thus one could grumble over a quotation from a paper to which reference is made in the article on hydrogen peroxide. But, among so much which is good and useful, to cavil is misplaced.

There is no doubt that this extensive and valuable encyclopaedia will find place on the shelves of many laboratories in spite of its bulk and its considerable cost. It will be valuable to the general reader who wants to widen his knowledge, for the articles are readable and informative, and to the specialist it will also be valuable as a work of reference, particularly if it is kept up to date by the issue of supplementary volumes. The specialist will, of course, find much which is omitted and perhaps much to criticize, but the attempt to present in this encyclopaedia the state of contemporary knowledge in all that pertains to chemical technology is certainly an ambitious one; in my opinion it is on the whole successful.

ALFRED C. EGERTON

HOUSE PAINTINGS IN ANGOLA

Subsídios Para a História, Arqueologia e Etnografia dos Povos da Lunda

(Museu do Dundo, Publicações Culturais No. 18.)
Por José Redinha. Pp. 32+55 plates. (Lisboa: Companhia de Diamantes de Angola, 1953.)

RESEARCH work on the archaeology and ethnology of the province of Lunda (Angola) in connexion with the Museum at Dundo is subsidized by the cultural department of the Belgian diamond company in Angola—Companhia de Diamantes de Angola. As a result, a number of splendid monographs have already appeared, dealing with various matters of interest in the area. The present volume is compiled by the curator of the Dundo Museum, Dr. José Redinha, and is concerned with paintings made by the natives on the clay walls of their houses, both inside and out, during the dry season of the year, June–September. The external paintings, at any rate, are completely destroyed during the rainy season. Except for a short explanation in Portuguese and a map, the volume is entirely devoted to coloured illustrations of the paintings. They are of very great interest to all students of art in the southern half of Africa. They do not recall the true bushman or pre-bushman art groups, but there is a feeling of similarity with some of the later art manifestations farther south. It is true that geometric design predominates in Lunda, but figures of animals and humans occur, and some of these are not unlike some of those found not so far away on rocks in south-west Africa.

There is no doubt that the Bantu have artistic ability. Canon Paterson, of Cyrene College, sent me some time ago a number of paintings made by Bantu children at the College, which he claims are free from European influence. They recall many to be found illustrated in the volume under review. Of course, the modern Bantu see things their forerunners never dreamed of—there is a delightful stylized picture of

a motor-car from a site near the River Chiumbe. But it does appear from Canon Paterson's evidence and now from the Lunda examples that the modern folk make elaborate paintings either on drawing paper or on the clay walls of their houses without having been taught by Europeans. The human beings sometimes appear in a very stylized manner, recalling those found in rock-shelters in southern Spain and dating there to the Copper Age. But there is no need to try to suggest any connexion because such conventionalizations of the human form occur in many places and are of many different dates; they occur, too, on the walls of rock-shelters in the New World.

The Diamond Company of Angola is to be congratulated on the time, trouble and money it devotes to archaeological and ethnological research. The present volume is a notable contribution to knowledge and, incidentally, is a delightful picture-book for one's study.

M. C. BURKITT

DISPERSAL PROCESSES IN FUNGI

Dispersal In Fungi

By C. T. Ingold. Pp. viii + 197 + 8 plates. (London: Oxford University Press, 1953.) 18s. net.

THE enormous fecundity of the fungi has long been known by those whose business it is to protect crops from attack by pathogenic fungi, or to prevent spoilage of stored materials by moulds and decay of timber by wood-rotting fungi. It is evident, too, to those who grow micro-organisms in pure culture on a laboratory or industrial scale. More recently its importance has been appreciated for another reason, for air-borne fungus spores have been identified as respiratory allergens, and in Great Britain the bulk of the microscopic dust particles suspended in outdoor air in summer seems to be either fungus spores or pollens. Bacteria also occur in outdoor air; but, as Pierre Miquel found seventy years ago, they are usually much less numerous than fungus spores—mainly because, unlike bacteria, the fungi have evolved a weird variety of mechanisms which propel their spores into the air. Other adaptations serve to aid their dispersal by animals, especially insects, and by water.

In this little book, which is addressed "to all those concerned with fungi as living organisms", Prof. Ingold lucidly describes the processes of fungus dispersal. It will be valued not only by the more academic biologists and by students with examinations to pass, but also will be a mine of information to those with a practical interest in the way fungi get into places where they are not wanted.

After a brief introductory survey, the remainder of the first-half of the book is taken up with a full account of spore liberation. Some of this material has been used in the author's well-known book on "Spore Discharge in Land Plants", and about a fifth of the excellent text-figures are from the same source. The new book, however, is in no sense a second edition of the earlier one. Dispersal processes after liberation are surveyed in the light of the rapid developments of the past dozen years. The processes of liberation accomplish only part of the dispersal process, and when discharged from its parent fungus body, the spore is transported to a greater or, more commonly, shorter distance by external agencies.

These are considered in the last half of the book in separate chapters on spores in the air, dispersal by insects, dispersal by larger animals; and there is a short chapter on seed-borne fungi. Not only is the literature surveyed in a stimulating manner, but also Prof. Ingold contributes original observations on nearly all these topics, especially in the final chapter on water as an agent in the dispersal of spores. Much still remains to be done, and, as he reminds us, many of the dispersal processes are still obscure. There are a bibliography of about 140 references and eight beautiful plates.

P. H. GREGORY

A SCIENTIST IN THE WORLD OF ART

Aesthetics and the Gestalt

A Collection of Essays and Other Writings. By Ian Rawlins. Pp. xi + 228 + 10 plates. (Edinburgh and London: Thomas Nelson and Sons, Ltd., 1953.) 18s. net.

THERE is nowadays a considerable number of scientists who are deeply interested in some or other of the arts, although the epoch of distinguished practitioners in both sides of the intellectual world is long past, perhaps since Leonardo da Vinci. Mr. Ian Rawlins is one of the far smaller minority who, officially trained in science, are able to indulge artistic interests to the extent of actual employment therein. He would not claim to be a creative artist, but he must allow us to recognize that he has a very weighty influence upon the arts; this influence he has exerted in two distinct ways, first as scientific adviser to the National Gallery and consultant on all questions of the safe keeping and material investigation of pictures, and secondly as a thinker and writer in the borderlines of general philosophy and aesthetics.

It is in this latter capacity that the reader meets him in this pleasant and often profound collection of essays. The principal adverse criticism might well be that the title is stupidly repellent: only a narrow range of British readers in science or art will be attracted by the word 'aesthetic', still fewer by 'gestalt'. Continental philosophical jargon causes English-speaking readers, even those concerned in the topics, to bristle like a dog, and it would be well to erase 'gestalt' from the dictionary as ruthlessly as most of us would erase 'existentialism'.

The little essays themselves belie that suggestion of self-conscious intellectualism. They are neat in thought and eminently readable, and even scientists who have thought the arts closed to them will find much to enjoy here. The pages range from a quantitative account of the atmospheric pollution of art galleries, through topics such as geometric theories of aesthetic appreciation, to historical problems from ancient Greece to modern Cambridge. Many are reviews which have appeared in *Nature*. After some cases, recently, of rather Victorian anti-religion in some scientific quarters, it is worth noticing how many of Mr. Rawlins's essays reveal a mind devoutly aware that there are aspects of experience needing other than scientific categories for their description. This is to be expected from someone who has escaped the narrowness of literary and material culture by opening a receptive mind to both.

MARTIN JOHNSON

Gem Testing

By B. W. Anderson. Fifth edition. Pp. 268. (London: Heywood and Co., Ltd., 1951.) 21s. net.

THE author, as director of the London Chamber of Commerce Precious Stone Laboratory, has unique experience in gem testing. That five editions of this book have been called for in ten years shows that it has filled a need both of the scientifically untrained jeweller, to whom it was originally addressed, and of the more advanced student.

Because of the value of the material, routine gem-testing must be non-destructive and is limited to physical methods. About half the text is devoted to their careful description and explanation. The basic physical properties, refractive index and specific gravity, serve to distinguish most of the natural gem species, although their determination is often made difficult by the mounting of the stone or limitations of the apparatus—for example, in the measurement of high refractive indices. A most useful additional property in such cases may be the absorption spectrum. Its use has been pioneered by the author to the extent that it now ranks as the key method in a number of cases. In this book is the only adequate description known to the reviewer.

With certain exceptions all these methods fail in that most important aspect of gem-testing, the distinction between natural stones and their synthetic, as opposed to imitation, counterparts, and the microscope becomes the *pièce de résistance*. Its use for this purpose is fully explained, and of the sixty-two text figures nearly half are photomicrographs; these are excellent in quality and selection.

The latter half of the text covers the identification of, and distinction between, all the principal gemstones, including those of organic origin such as pearl and amber. In this, as in the first section, useful hints and examples abound. There are also an alphabetical summary of properties in tabular form, a glossary, tables of specific gravity and refractive index, and suggestions for further reading. Despite its superficial simplicity, this is an authoritative work, well produced in clear type.

G. F. C.

Geography from the Air

By F. Walker. Pp. vii+111+96 plates. (London: Methuen and Co., Ltd.; New York: E. P. Dutton and Co., Inc., 1953.) 30s. net.

THIS book provides a useful introduction to the correlation of geographical data with the air photographs from which maps are finally constructed. Such a technique is most favoured in undeveloped countries where information is otherwise not rapidly obtainable; but in Great Britain, the only source tapped by the author, many geographical and ecological features have been made or modified by man, and excellent maps prepared by more pedestrian methods exist. It would be desirable to include and discuss examples—which are certainly available from the British Dominions and Colonies—of untouched virgin country in diverse geographical, geological and climatic provinces; and to consider the uses of oblique photography, monochromatic filters, the habits of vegetation growing under natural control, and weathering action differing from that of the British Isles.

As regards details: it is not necessarily true (p. 11) that geological facts evident on air photographs are equally well observed on the ground, nor (p. 1) that there is no vertical scale distortion in a

stereo-pair—it can be troublesome over mountainous country. Reference to the page-numbers of the text-descriptions ought to be made on the plates, only three of the ninety-six embodying pairs for viewing with a pocket stereoscope. Since the main force of the technique lies in the three-dimensional appreciation, the inclusion of more of such pairs would be preferred, though the effect of the process screen is disturbing. Plate 37 (p. 1 of text) should be Plate 38.

In recognizing that examples from overseas are lacking and that archaeology and photogeology have received but scant attention, the author has disarmed criticism, for the subject is expertly handled within the limits chosen; but it is worthy of a wider range of treatment. This would be welcome in a later edition, which might well include a selected bibliography.

D. W. BISHOPP

Ants

By Derek Wragge Morley. (New Naturalist Series.) Pp. xii+179+15 plates. (London: William Collins, Sons and Co., Ltd., 1953.) 18s. net.

THE pleasantly discursive story of the author's own observations on the habits of ants, in Chapter 1, might have formed the happy beginning of a book for the non-technical reader with an interest in natural objects; the notes on the various species and the illustrated key, though not free from defects, could serve the same purpose. But as a scientific monograph that is said to give "a clear and excellent summary of the knowledge of these fascinating creatures", this book is scarcely a success. There is little of moment that cannot be found in Donisthorpe, Wheeler and nineteenth-century authors; the book lacks coherence and precision; and some of the truly fascinating aspects of ant biology, such as the structure and development of the colony and the determination of the castes, are virtually omitted (except for some details of mixed colonies). The chapters on anatomy are heavily weighted with details that are of interest principally in systematic work: in many cases the terminology is old-fashioned (for example, "chitin" for 'cuticle', p. 33; "bourrelet glands", p. 124), and there are a number of odd mistakes (for example, "mesonotal sternite", Fig. 5). The growth of ants is dismissed with extreme brevity; the distribution maps, given for every species, are often incomplete (for example, *Monomorium pharaonis*, which now has a respectable Scottish literature, is shown nowhere north of Essex). Some of the photographs, however, are excellent; it is a pity that the text is scarcely of the same standard.

J. A. DOWNES

Chemistry of Carbon Compounds

A Modern Comprehensive Treatise. Edited by Dr. E. H. Rodd. Vol. 1, Part B: Aliphatic Compounds. Pp. xvii+779+1462. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1952.) £5 15s.

THE second part of Vol. 1 of this work carries on the discussion of the aliphatic series begun in the first (reviewed in *Nature*, 170, 508; 1952) and deals with the more complex (and therefore more interesting) compounds of this type. After a description of the hydroxy-, amino-, aldehydo-, keto- and poly-carboxylic acids, there follows a series of chapters on the carbohydrates and their multitudinous derivatives. Authoritative coverage of this latter topic has been ensured by the expert knowledge of

Dr. J. K. N. Jones and the late Dr. E. G. V. Percival; the full and detailed treatment renders this section a very valuable source of modern information for the carbohydrate chemist. The volume ends with chapters on the proteins and the enzymes which supply the scaffolding of the modern ideas concerning these vital substances together with ample references for further detailed study.

The characteristic of the work developed in the first volume—that is, the ready availability of up-to-date leading references—is well maintained in the second part of this important compendium.

Physical Chemistry made Plain

An Aid for Intermediate Students and Others. By J. H. Mandleberg. Pp. viii+287. (London: Cleaver-Hume Press, Ltd., 1952.) 15s. net.

THE author, an industrial chemist, calls himself "a chronic and incurable non-mathematician". His purpose is to teach physical chemistry, at post-matriculation level, mainly through numerical examples, and he thereby hopes to promote its study "by removing some of its terrors". The material is divided into seventeen chapters. The author's method is to recount the general principles of the subject under treatment, to work out several illustrative numerical examples in considerable detail, making the procedures abundantly clear, and to add many more for the student to solve; answers are given to all the problems.

Great pains have been taken to meet the needs of less able students, and in this respect the work is exceedingly well done. Still, understanding comes to many a student only when he sees the graph drawn of the problem in question; yet, there is neither graph, labelled diagram nor line-illustration in the book. Moreover, I find but little support for the claim that "an attractive feature is the frequency with which the student is reminded of the relevance of his work to industrial processes". The author gives brief mention of some principles not susceptible of quantitative treatment at this level, but others he omits. The preface calls this book a "review of physical chemistry": it would be preferable to call it a book of chemical calculations. G. FOWLES

Thermal Diffusion In Gases

By K. E. Grew and T. L. Ibbs. (Cambridge Monographs on Physics.) Pp. xi+143. (Cambridge: At the University Press, 1952.) 22s. 6d. net.

THERMAL diffusion in gases was predicted theoretically long before it was observed experimentally, and it is only during recent years that the consequences and importance of this effect have been fully developed. The immense stimulus given to the study of thermal diffusion and related phenomena by the utilization of this method for the separation of isotopes and gas mixtures resulted in a considerable output of experimental work. The publication of this monograph, which summarizes these developments, will be especially welcomed.

The emphasis in the monograph is largely on the experimental aspects, and Chapters 1-5 consist of an introduction to the theory of diffusion in gases, an account of the experimental methods and results, and the correlation of results with theory. In Chapter 7 the related phenomenon, the diffusion thermo effect—that is, the setting-up of a transient temperature gradient when one gas diffuses into another initially at the same temperature—is discussed from both the theoretical and experimental

aspects. The remaining Chapters 7 and 8 describe the application of thermal diffusion to the separation of the components of gas mixtures and thermal diffusion in the liquid phase, respectively.

This is the only book of its kind containing both a comprehensive survey of the experimental field and a careful and clear exposition of the underlying theory. The book is well written and excellently produced, and it can be recommended to all interested in this subject.

Photoconductivity In the Elements

By Dr. Trevor Simpson Moos. Pp. x+263. (London: Butterworths Scientific Publications, Ltd., 1952.) 50s. net.

PHOTOCONDUCTIVITY is a subject which claims attention on two grounds: it provides a useful tool for examining certain aspects of the nature of the solid state and it has useful practical applications. Photoconductive materials have been studied intensively during the past few years, and this up-to-date book by Dr. T. S. Moos is therefore to be welcomed.

The book is divided into two parts. Part 1 is concerned with theoretical aspects of the properties of photoconductors. The treatment is clear, but the reader is assumed to have the background of, say, a physics graduate; those without this background will, however, be helped considerably by the numerous references given in the text. Part 2 gives a detailed review of experimental studies of the properties of certain photoconductive materials; photoconductive compounds are not included in this review, which is confined to the elements boron, carbon (diamond), silicon, germanium, grey tin, phosphorus, arsenic, antimony, sulphur, selenium, tellurium and iodine.

As a whole, the book is concise and well written; it provides a useful, if somewhat limited, survey of an important subject. A. H.

Dynamical Oceanography

By Prof. J. Proudman. Pp. xii+409. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1953.) 55s. net.

THIS book covers most of the principles of hydrodynamics that have application to oceanography. The author has a genius for concentrating on the central features of a problem. In a large part of the book the problem is not to solve the hydrodynamical equations, but to show how much can be derived from a few simple properties without actually solving them in detail. In the application to mean conditions, and therefore to steady states, a great deal can be done from continuity of mass and quantity of salt and the circulation theorem, particularly toward estimation of currents far from land. Turbulence and mixing are treated in some detail. Variation of conditions with time appears first in these chapters, in which estimates of eddy-viscosity appear. The rest of the book deals with tides, seiches and waves. The treatment has been deliberately confined to the simpler problems, and little is said about the formidable ones on tides in the open ocean that have been solved by the author and his colleagues.

Quantitative applications appear at many points, with checks against observation whenever these are available. The agreement is in some cases astonishing—for example, the calculation of co-tidal lines for some narrow regions with complicated boundaries, such as the English Channel. HAROLD JEFFREYS

THE MEDICAL RESEARCH COUNCIL LINEAR ACCELERATOR AND CYCLOTRON

By CONSTANCE A. P. WOOD and G. R. NEWBERY

A NEW building (see Fig. 1) has recently been completed for the Medical Research Council at Hammar Smith Hospital, London. This building houses two large machines for the acceleration of atomic particles. Installed in the south end of the building is an 8-MeV. travelling-wave linear electron accelerator; this machine has been designed specifically for X-ray therapy and is already in daily use for the treatment of patients. At the north end of the building, a 45-in. cyclotron is under construction. The central portion of the building consists of research laboratories on the upper floors and clinical rooms for patients on the ground floor.

The linear accelerator is installed in a treatment room (see Fig. 2) which is surrounded by walls of concrete four to six feet in thickness. There is no door to the treatment room; but easy access is afforded by means of an indirect corridor with concrete walls on either side. The protection thus afforded is much greater than is necessary simply for the safety of personnel; it is sufficient to enable work to be carried out in the adjacent research laboratories involving the measurement of minute quantities of radioactive material with Geiger counters and high-pressure ionization chambers. The radiation level at the control desk is less than one-hundredth of the recognized tolerance value. The



Fig. 2. Treatment room

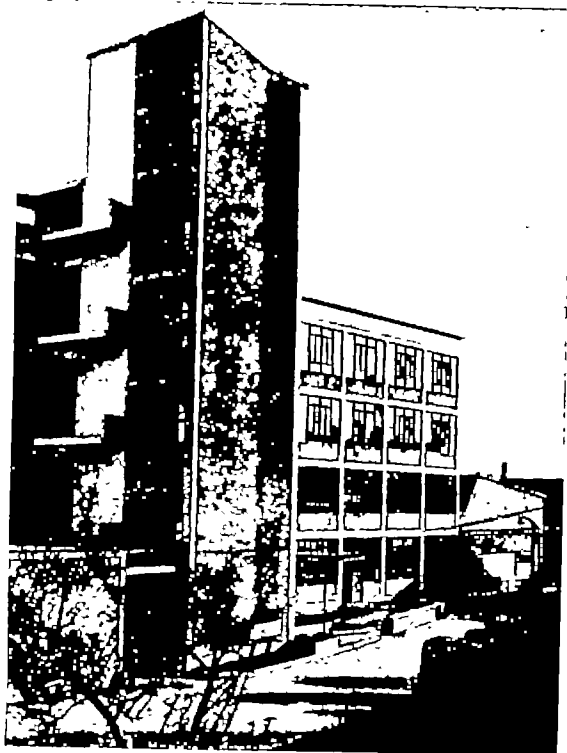


Fig. 1. Building for the Medical Research Council linear accelerator (right) and cyclotron (left)

operator at this control desk can see the patient under treatment by means of a periscope system of mirrors viewed through an air tunnel in the concrete wall.

The technical details of the 8-MeV. linear accelerator have already been described by Miller¹. The accelerating tube is three metres in length; it is suspended from the ceiling, thus leaving the floor of the treatment room clear. The 8-MeV. electron beam passes out of the end of the accelerating tube into a rotatable X-ray head. In this, an electromagnet bends the electron beam through a right-angle before it strikes the gold transmission target to produce the beam of X-rays. The X-ray beam is then collimated to a maximum diameter of 28 cm. at 1 metre from the target by passing it through a conical hole in a series of tungsten-copper alloy blocks. The final dimensions of the X-ray beam can be controlled by means of an adjustable diaphragm system consisting of four 3-in. thick tungsten-copper alloy blocks moving in two interlocked pairs in a single plane. Thus any size of treatment field can be obtained, from 4 cm. to 20 cm. square, or any intermediate rectangle. Scales are provided for setting the size of the field, and circular fields can also be obtained by suitable inserts of tungsten alloy. The target-to-skin distance usually employed in treatment is 1 metre.

A lamp and mirror are provided to illuminate the treatment area on the patient's skin. In addition, front and back pointers on the X-ray head indicate the points of entry and exit of the central axis of the X-ray beam on the patient's skin. The dose-rate and the total dose administered in any one treatment are measured by ionization chambers built into the head of the machine and connected to d.c. amplifiers.

By rotation of the X-ray head, the X-ray beam can be directed accurately into the patient at any desired angle. To enable the patient to be brought into position in the X-ray beam, the whole floor of the treatment room can travel vertically up and down over a distance of 5 ft., and in addition a specially designed treatment couch can travel horizontally across the moving floor. The angular motion of the X-ray beam, the vertical movement of the floor and the horizontal movement of the couch can be automatically co-ordinated by an electronic servo system enabling the patient to be moved in an arc around the machine. As a result, once the entry point of the beam (marked by the front pointer) has been set correctly on the patient's skin, it is possible to adjust the angle of the beam until the exit point (as shown by the back pointer) is also correct, without ever altering the entry point. By this arrangement patients can be set up for treatment on this machine with greater accuracy and speed than is possible with the conventional type of X-ray equipment.

The high intensity output of the linear accelerator, 100–200 rads per minute (1 rad = 100 ergs per gm.) at a metre, is of great value in the treatment of patients, since the time of each treatment is thereby reduced to about two minutes. The initial large expense of the machine is thus to a great extent offset by the much larger number of patients who can receive treatment in a given time.

The control desk of the machine is simple and can be operated in the usual way by radiographers. The required dose can be set in steps of 10 rads up to a maximum of 600 rads; the machine switches itself off automatically when the prescribed dose has been administered.

There are, for the first time, incorporated in this one machine all the facilities needed to permit the full exploitation of the technical advantages to be gained by using very-high-energy X-rays in the treatment of malignant disease. It makes possible the delivery of an adequate dose to a deep-seated tumour of highly penetrating 8-MeV. X-rays collimated into a well-defined, high-intensity beam, which can be conveniently and accurately directed into the patient at any angle.

In Fig. 3 a comparison is made of the penetration of X-rays produced at 8 MeV., at 2 MeV. (approximately equivalent to radiation from a 1,000-curie cobalt source) and the conventional 200-kV. X-rays; the greatly increased penetration obtained at 8 MeV. is clearly shown. This figure also illustrates the build-up of intensity below the skin at 2 and at 8 MeV. This build-up, which occurs with supervoltage radiation, is due to the fact that the secondary electrons, which produce most of the ionization, are projected mainly in the direction of the incident beam and have a range which increases with the voltage. In the case of the 2-MeV. X-ray machine and the cobalt unit, the maximum dose is at 0.5 cm. depth, whereas this occurs at a depth of 2.0 cm. with 8-MeV. X-rays. This build-up of intensity below the skin and the high penetration of the X-rays produced by the 8-MeV. linear accelerator make

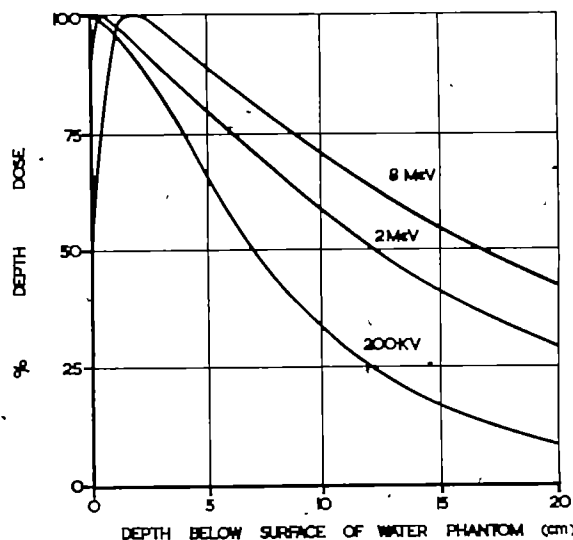


Fig. 3. Comparison of central axis depth doses for a 10 cm. x 10 cm. X-ray field, 200 kV., 2 MeV., and 8 MeV. in a water phantom.

possible the delivery of an adequate dose to a deep-seated tumour without any damage to the overlying skin.

At one time it was thought possible that supervoltage X-rays might have a different biological effect from 200-kV. X-rays. A clinical experiment was therefore carried out at the Radiotherapeutic Research Unit of the Medical Research Council to compare the biological effect of 200-kV. X-rays and a radium beam which is equivalent to 2-MeV. X-rays¹. As a result of this experiment, it was concluded that the great advantage to be expected from the use of supervoltage therapy was not in any different biological effect but only in the enormously improved dosage distribution which can be obtained by this means. Experimental biological work has since re-emphasized the fact that there is no great difference in biological efficiency between 200-kV. X-rays and those generated at much higher voltages.

To what extent this improved dosage distribution may increase the rate of cure in the radiation treatment of malignant disease only a prolonged clinical trial can determine. One advantage which is certain is that it will be possible to treat patients with a much greater degree of comfort. The reduction of skin reaction itself is of great value in X-ray therapy, and it can also be safely assumed that the lower absorption of energy in bone as compared with soft tissue, which occurs in supervoltage X-ray therapy, will lessen the risk of bone necrosis and so contribute to the success of treatment.

The 45-in. cyclotron, weighing some 180 tons, is still under construction; this machine is housed at the north end of the building in a large concrete room with ceiling and walls from six to ten feet in thickness. The room has two close-fitting sliding concrete doors weighing 35 and 190 tons. The cyclotron will be operated from a remote-control room.

The beam of fast neutrons which can be produced by the cyclotron will enable investigations to be carried out to determine the effect of neutrons on living and inert matter. There is no question of the efficiency of neutrons in destroying malignant cells. What is not known is whether this property can be

turned to advantage over other forms of radiotherapy in the treatment of malignant disease in patients.

Another use of the cyclotron lies in its ability to produce certain radioactive isotopes which cannot be produced in the atomic pile. The particular importance of this cyclotron lies in its ability to produce in a hospital certain isotopes which, on account of their very short life, must be used immediately they are produced. Facilities have been provided adjacent to the machine for this purpose.

¹ *Nature*, 171, 297 (1953).

² Wood and Boag, M.R.O. Special Report Series No. 287, "Researches on the Radiotherapy of Oral Cancer" (London: H.M.S.O.).

DEXTRAN AND ITS APPLICATIONS

ON the evening of December 3 the Microbiology Group of the Society of Chemical Industry held a meeting in the hall of the Medical Society of London, 11 Chandos Street, London, W.1, presided over by Dr. L. A. Allen, at which various applications of dextran were discussed.

Prof. M. Stacey introduced the subject with a paper on "Polyglucose Structures with Special Reference to the Dextran Group". He commented on early work in Sweden and in Birmingham, saying that the dextran polysaccharides have achieved an important medical use as blood plasma substitutes or blood volume expanders, and their derivatives are possible anticoagulants. Since they can readily be produced from cane or beet sugar by fermentation methods on an industrial scale, other uses, such as colloids of precise size and shape, will doubtless be found for them.

Chemical and physical methods of carbohydrate chemistry are now so well developed and of such diversity that we can now determine with great accuracy the homogeneity, size, shape and molecular structure of most polysaccharides. Homogeneity can be determined by physical techniques such as measurements of optical rotation, electrophoresis, ultracentrifugal properties, diffusion, scattering of light, and immunochemical studies, all of which also give information on molecular size and shapes. Constituent units can be determined by hydrolysis with acids followed by paper and column chromatography, ionophoresis, etc., while acetylation, methylation, periodic oxidation, infra-red studies, ionophoresis, etc., pick out the nature of ends of chains, repeating units, types of linkage and structures generally. Number average and weight average can all be determined by classical methods for dealing with macromolecules; for example, the physical methods already mentioned, viscosity measurements, and methods involving reaction at reducing-chain ends such as copper number measurements and the addition of labelled hydrogen cyanide.

Almost every type of polyglucose structure is now known where the glucose units are in the pyranose form. In starch the amylose component is a chain of at least two hundred glucose units joined by (1 → 4)- α -linkages, while the ramified amylopectin has short chains of twenty glucose units joined as in amylose but cross-linked by (1 → 6) linkages. Glycogen consists of shorter chains with (1 → 4)- α -linkages and (1 → 6) cross-linkages. Cellulose is entirely linear with very long chains of probably a thousand

glucose units linked in the (1 → 4)- β manner. The polyglucose made by the crown gall micro-organism possesses mainly (1 → 2) linkages, while the yeast 'glucan' has mainly (1 → 3) linkages. *Nigeran* from *Aspergillus niger* has alternating (1 → 4) and (1 → 3)- α -linkages, and luteose from *Penicillium cubal* has a long glucosan chain with (1 → 6)- β -linkages.

The predominating linkage in the dextrans is the (1 → 6)- α -linkage, but a variety of types is known varying from completely linear structures to highly ramified types with additional (1 → 4)- α - and (1 → 3)- α -cross-linkages and combinations thereof. All are macromolecules with molecular weights of the order of millions. Great interest arises in methods for degrading the dextrans and in separating and selecting homogeneous fractions for infusion purposes. Breakdown can be effected by acidic, alkaline, enzymic and oxidative hydrolysis, or by ultrasonic or thermal treatment. Fractionation precipitation techniques, using mainly organic solvents and aqueous solutions, not only separate large and small molecules but will also pick out linear from branched chains—the infra-red technique being useful for rapid control of fractionation.

Recently, it has become possible to control the enzymic synthesis of polyglucose molecules and indeed to grow them to size. Great advances have been made in the enzymic synthesis of starch and glycogen. For these, phosphorylase acts upon glucose-1-phosphate to give the straight-chain amylose. This may then be acted upon by the branching 'Q-enzyme', which effects chain-shortening by breaking about one in every twenty (1 → 4)- α -linkages and which then re-forms the molecule by creating (1 → 6) cross-linkages giving the highly laminated structures of glycogen and amylopectin. This 'transglycosylase action' is responsible for synthesizing the highly branched dextrans, for at least two enzymes seem to be involved: a (1 → 6)- α -linked straight-chain former and a transglycosylase which forms (1 → 4) and/or (1 → 3) linkages.

For polysaccharide synthesis generally three factors are needed: enzyme, specific substrate and receptor molecule. For dextran synthesis by *Leuconostoc* species, sucrose is a highly specific substrate, and preformed dextran forms the receptor molecule or 'primer'. When a small number of large dextran molecules is used to prime the reaction, macromolecules of very large size result. When a relatively large number of small dextran molecules is used to provide receptor groups for synthesis from non-reducing chain ends, they are all lengthened to the same extent, and relatively small dextran molecules result. Thus, it is now possible actually to grow dextran 'to size'—for example, to molecular weights of seventy thousand for infusion purposes. The method uses the living cell, whereas American workers are studying similar polymerizations with isolated enzyme systems.

Mr. A. E. James then presented a paper on "The Technology of Dextran Production", showing that the production of dextran for use as a plasma volume expander may be divided into five main stages: fermentation, degradation, fractionation, purification and final testing after bottling. Dextran is produced as a large macromolecule during the fermentation of sucrose by a selected strain of *Leuconostoc mesenteroides*, although the use of the dextran 'sucrase' enzyme has been reported in the United States. The dextrans produced by different organisms vary from almost linear to highly branched molecules. The

reduction of the molecular size of the native dextran to approximately that of the blood proteins may be achieved by several degradative steps such as acid or alkaline hydrolysis, thermal or pyrolytic breakdown, irradiation with ultrasonic vibrations or enzymic breakdown. Recent work has indicated the possibility of direct synthesis of the required molecular weight, thus avoiding degradation.

The material from degradation is very poly-disperse, and the objectionable larger molecules and the useless small ones have to be removed by selective precipitation. Acetone and the lower alcohols have been used as precipitating agents. This process does not yield a homogeneous dextran with respect to molecular weight, and the commercially available transfusion solutions contain a range of molecular sizes dictated partly by medical requirements and partly by economic considerations. Ultrasonic degradation appears to be unique, as it yields a product requiring virtually no fractionation to yield a satisfactory medical preparation.

The desired fraction of dextran is freed from precipitants, pyrogen, ionic impurities and colour by selective adsorption and ion-exchange, and may then be filled directly as a solution in water, sodium chloride solution or glucose solution. Alternatively, it may be spray-dried for bulk testing and distribution. After bottling, rigorous chemical bacteriological and pharmacological tests are applied.

Dr. F. Fletcher followed with a discussion of the "Properties of Dextran from the Physiological Aspect". He pointed out that the maintenance of a normal blood volume depends on the hydrostatic pressure of the capillary blood and the colloidal osmotic pressure gradient between the plasma and tissue protein. Plasma contains albumin, globulin and fibrinogen; but it is the albumin fraction (55 per cent of total protein) of molecular weight about seventy thousand which mainly contributes to the colloidal osmotic pressure.

It is essential that any colloid intended as a replacement for plasma protein be retained in the blood vessels and not rapidly lost through the capillaries to the tissues or urine. The retained colloid must exert a colloidal osmotic pressure similar to that of the normal plasma protein. Dextran can be prepared to meet these criteria and is a satisfactory substitute for plasma protein.

Dextran fractions of various ranges of molecular weight have been studied, and the distribution and excretion-rates have been compared. The molecular-weight distribution of such fractions can be determined by ultracentrifuge, scattering of light, or techniques of the measurement of osmotic pressure, but it is more usual for measurements of intrinsic viscosity to be made. The relationship between intrinsic viscosity and molecular weight has been published by various workers.

The distribution of dextran in the body is influenced by its molecular-weight distribution. Relatively small molecules below a weight-average molecular weight of sixty thousand are excreted in the urine within a few hours after administration. Molecules slightly larger can also pass readily through the capillary walls into the tissue fluid, thus tending to reduce the effective osmotic pressure gradient. Therefore, on the basis of these physiological considerations, the higher molecular range of dextran used in Britain appears to be preferable for clinical use compared with dextran fractions of lower average molecular weight.

Prolonged storage of a non-physiological colloid in the body is undesirable. That dextran is metabolized in the body has been suggested by the finding of radioactive carbon dioxide in the expired air of animals receiving injections of dextran labelled with carbon-14, obtained by the *Leuconostoc* fermentation of radioactive sucrose. Structural differences exist between dextrans produced by different strains of *Leuconostoc mesenteroides*, and immunological studies on structurally different types of dextran might influence the type of material selected for clinical use.

Mr. A. W. Wilkinson continued the physiological discussion with a paper on "The Clinical Applications of Dextran". After paying a tribute to Prof. Stacey and other pioneer workers on dextran, he commented on its importance in blood studies, and went on to say that the cells of the living body are surrounded by an environment of extracellular fluid; at any moment this extracellular fluid may be arbitrarily divided into one quarter, which is within the blood vessels in the form of plasma, and three quarters, the interstitial fluid, which is outside the blood vessels in the immediate neighbourhood of the cells. This separation depends on a balance between the hydrostatic forces in the blood vessels and the interstitial space, and the osmotic pressure of the plasma proteins. In normal tissues flow in the capillaries is intermittent and depends chiefly on requirements related to tissue activity. After injury there is a very marked increase in capillary permeability in the injured tissues and the volume and protein content of interstitial fluid increases, this increase in volume being due to a greater turnover of fluid rather than to simple local accumulation, because lymph formation is also increased up to eight times. If the injury is large, so much fluid may be lost from the blood vessels that the volume of blood in active circulation may be reduced enough to cause reduction of the peripheral blood pressure and a state of 'shock'. Shock may also be caused by loss of whole blood. It is now recognized that, in shock, capillary permeability is increased only in the injured tissues.

The most satisfactory treatment of shock is by the early, rapid and complete replacement of lost blood or plasma by the transfusion of blood, plasma or a substitute for plasma, such as dextran. To be successful as such a replacement, the dextran must be fractionated so that as little as possible is lost in the urine or through the unusually permeable capillaries of the injured tissues and as much as possible remains within the vessels.

The effects of injecting a litre of a 6 per cent solution of dextran in 0.9 per cent saline have been studied in normal volunteers. There is an immediate reduction in packed cell volume and of total plasma protein and plasma albumin concentration. These changes afterwards slowly pass off, and the plasma dextran concentration, initially 1.1-1.5 gm./100 ml., falls slowly over 8-10 days to less than 0.1 gm./100 ml., but even at this time the packed cell volume remains below the original value. Detailed study of the changes during the first 24 hours after the infusion has shown that during the 2 hours or so following the initial increase in plasma volume, which varied from 0.3 to 1.3 litres, there is a reduction in plasma volume almost to the initial quantity. During this short period more than 40 per cent of the total quantity of plasma albumin in solution and nearly 40 per cent of the injected dextran leave the blood vessels. During the next 8-12 hours there is a gradual increase in plasma volume, and

the quantity of plasma albumin in circulation increases to that found immediately after the infusion stopped; but the increase in total circulating dextran is much less. After 24 hours only 8 per cent of the injected dextran has been recovered in the urine and 65-75 per cent remains in circulation within the vessels, so that about 20 per cent is untraced. The explanation of these changes seems to be that the acute overloading of the circulation produced by the rapid injection of this dextran solution is relieved by the loss of intravascular fluid into the interstitial space, with subsequent slow return over the next 8-12 hours. Similar results have been obtained in shocked patients, and two examples of the rapid and lasting improvement in blood pressure and clinical state were described.

All these volunteers exhibited 'reaction' which could be resolved into two phases, urticarial and vasomotor, that were separated in time. Whereas the urticarial phase may be due to the peculiar characteristics of the dextran used, the vasomotor phase seems to be related to the rapid shift of fluid from vessels to interstitial space.

Finally, Mr. A. R. Lockwood briefly reviewed "The Utilization of Dextran and some of its Derivatives". The current utilization of dextran in non-clinical applications depends largely upon the economic separation of the crude polysaccharide from the crude fermenter broths. Solvent precipitation is the only practical means so far employed, but is costly and must usually be followed by spray or roller drying. Some attention has been directed to using the whole fermenter broth—for example, in oil-well drilling muds and edible syrups. Sugar syrups made by the addition of sucrose to *Leuconostoc* pure cultures form an effective way of conveying dextran into a variety of food products without the problem of prior separation.

Derivatives of current interest include the sulphuric polyesters, which have a heparin-like blood anticoagulant action; some of them have been shown recently to be suitable for clinical use. The carboxymethyl ethers are likely to have superior stabilizing powers compared with the neutral polysaccharides. Other ethers and mixed ether/esters have been described, of which the most interesting is the polymerizable allyl derivative. Attention has been directed to the importance of microbial polysaccharides in soil structure; but the exploitation of dextran in this field may have to follow the development of large-scale, low-cost crude dextrans, possibly from the direct fermentation of natural sugar juices.

The discussion at the meeting was opened by Dr. C. R. Ricketts, who said that he thought dextran production might be regarded as the dextran industry now that there are six or eight factories engaged in it. He thought that the present phase of 'tailoring' the molecules of dextran after its initial preparation would be followed by direct production, by fermentation, of the molecular size and form required. The work on the effect of addition of short-chain dextrans and of sugars to the fermentation mixture in modifying the dextran produced provides a fruitful field for simplification in manufacture of the kind suggested and might have an important effect on making preparations for clinical use.

In reply to a question by Mr. D. Armstrong why dextran of a molecular weight of sixty thousand is excreted by the kidney whereas albumin of similar molecular weight presumably is not, Dr. Fletcher said that molecular shape is also important in

excretion and that albumin can be re-absorbed back from urine by the kidney whereas dextran cannot. Mr. A. L. Bacharach suggested that in practice this matter is approached empirically and is not based on purely physiological concepts. In commenting that Prof. Stacey's paper showed the advantages of ultrasonics in achieving uniformity of molecular size, Mr. H. F. Frost asked if this method is used commercially, and Mr. Lockwood replied that there has been difficulty in getting large ultrasonic units of suitable types but that they are now being employed. Dr. D. H. F. Clayson asked if the breakdown of dextran in the body is due to attack of the (1 → 6) linkages and, if so, could it be controlled by adding inhibitors such as amylase to the blood. Prof. Stacey replied that there is no knowledge yet on either of these points, for no enzymes which could break such linkages have been isolated from body fluids. An inquiry was made by Mr. H. J. Bunker as to the raw materials for the large-scale development of dextran to which Mr. Lockwood referred, and Prof. Stacey replied that any sugar material can be used, including dextrins, and that recent restrictions in production in the Jamaican sugar industry because of over-production suggest that even raw cane sugar might be available for the purpose. Cane sugar undoubtedly must be one of the most important raw materials of the future. Mr. J. Green asked Mr. Wilkinson what was his evidence for saying that the dextran should not have molecular weight above three hundred thousand for clinical use, and the latter said that above this value aggregation of red cells can be demonstrated and this is said to be undesirable; he thought that this tendency might well not be of great importance, since turbulence in the capillaries could be expected to overcome it.

THE SHIRLEY INSTITUTE

ANNUAL GENERAL MEETING

THE thirty-fourth annual general meeting of the British Cotton Industry Research Association was held at the Shirley Institute, Manchester, on December 10, 1953, under the presidency of the chairman of the Association, Mr. N. G. McCulloch. In his speech Mr. McCulloch referred particularly to the statutory levy that came into operation during 1953, as a result of which all cotton processors in Great Britain now contribute to the Institute and are eligible to take advantage of the services which the Institute offers. He hoped that all new members would take full advantage of this opportunity. Mr. McCulloch also emphasized that firms who process rayon and synthetic fibres are encouraged to continue in membership or become new members, since so much of the Institute's work is concerned with, or applicable to, these fibres as well as to cotton. The honorary treasurer of the Association, Mr. J. Lindley, also referred to the levy, and paid special tribute to the generous way in which the industry had responded to the appeal for funds which it had been necessary to make in order to tide the Institute over the period before the first collection of the levy.

Dr. F. C. Toy, director of research, presented his annual report and directed attention to the more important of the year's activities. He mentioned especially two essays in the educational field: the travelling exhibition of the Institute's work on sizing

and weaving, and a course of lectures on card-room planning which had been given at the Institute and attended by more than a hundred and fifty mill representatives. Dr. Toy referred to the importance of work proceeding on mixed fibres, particularly mixtures of natural and synthetic fibres such as cotton and nylon. All in all, he said, the year had been an exciting one, marked by advances on both the scientific and technological fronts.

In the laboratories, which were open for inspection after the meeting, many of the researches attracted particular attention. The most interesting exhibit for spinners was the 'Shirley opener', a machine which had already attracted considerable attention at the exhibition of textile machinery at Belle Vue, Manchester. Separating lint from trash aerodynamically, by the use of stream-line air flow, it saves space and time in the mill. For the more scientifically minded, an apparatus for examining stroboscopically the form of ballooning yarns on spinning machines and for measuring the tension was shown, as were various devices for following the movement of fibres during drafting and measuring the forces involved. In the experimental spinning-room there was further evidence of work designed to improve quality and productivity.

In the Weaving Department, the automatic size-box was on view. By the use of this device, which employs a new principle of control that is independent of such factors as the viscosity of the hot starch paste, or size, which is used for protecting the yarn in weaving, warp yarns can now be prepared for weaving in such a way that there is complete and automatic control, at the machine, of the amount of solid material applied to the yarn. The Institute has for many years concerned itself closely with the problem of finding sizes that give good performance in weaving and with analysing the effects of the lubrication and adhesion provided by the size ingredients, and more recently there has been particular emphasis on the relatively difficult problem of finding sizes for hydrophobic fibres such as nylon and 'Terylene'. A small-scale sizing equipment, in which all the variables are under control and on which small quantities of yarn can be sized rapidly, was shown.

The 'Shirley rayon loom', which has been designed to take account of all the physical and engineering knowledge that has been gained from researches into weaving and loom mechanisms over past years, could not be shown as it is still being developed in co-operation with a loom manufacturer. However, the separate mechanisms, some of which were also shown in the travelling weaving exhibition, were to be seen. These have been designed by physicists and engineers working together, and prototypes have been developed in the Engineering Department.

The staff of the Finishing Department were able to discuss with members their work on physical and chemical problems over a large field. The behaviour of pressure bowls during calendaring and mangling has been examined in a preliminary manner photographically, and, in the calender, more carefully and accurately by a photoelastic technique which has given interesting results. The experimental calender and mangle constructed in the engineering shop were shown. The chemical engineering section of the Department is interested in two main problems: drying, with the emphasis on convection and suction dryers; and fluid flow with particular reference to the dyeing of closely wound packages. The experimental equipment in a new and well-equipped

laboratory of this section was shown for the first time. Physicists and chemists shared in discussing with members the work on printing. The young science of rheology comes into its own in this branch of the textile industry, since the non-Newtonian materials used for printing on fabrics are used at a wide range of rates of shear. The chemists find great interest in the consideration of starches and gums used in printing pastes.

In the Rayon and Silk Departments two problems of great interest to the chemist are under consideration. In the Rayon Department, work has proceeded for some years on the fractionation of regenerated celluloses according to their molecular weight, using osmotic and viscometric methods for the determination of molecular weight, together with an ultra-centrifuge designed and built at the Institute. This work has now reached the interesting stage where the physical properties of fibres prepared from specific fractions are being examined. In the Silk Department, the recent rapid developments in paper chromatography have been of considerable help in the problem of elucidating protein structure, with particular reference to the main constituents of the silk fibres fibroin and sericin. The more chemically minded visitors also found plenty to interest them in the fundamental work of the Chemistry Department, where the particular interest for many years has been the light shed on the structure of cellulose by studies of its oxidation.

The Physics and Physical Testing Departments are now housed in the new building, completely occupied for the first time in April 1952; some members were still interested in the design of the building, and particularly in the disposal of services and the means adopted for ensuring controlled humidity and temperature throughout the laboratories. Many were interested in the activities of the Testing Department, for it is there that much of the work on quality control is carried out, and particularly in the design of instruments. It is there also that much of the programme on blended fibres will be done, since the accumulated knowledge on the structure and mechanics of textiles lies there. Much of the more fundamental work on the physical properties of textile materials is done in the Physics Department; but perhaps of greatest interest to visitors was the work on the 'barrier' properties of textiles. Textile materials are almost invariably used as a barrier to something; it may be to heat, light, sound, water, water vapour, etc. Much work has been done, and will continue to be done, on the production of textiles which allow the passage of water vapour but not of water. More recently work on the properties of textiles as a barrier to dirt has been started, and it is hoped that in time much information will be obtained on the mechanism of soiling. In the meantime, members showed interest in an apparatus which has been developed in the course of this work for the convenient and rapid measurement of atmospheric dirtiness. Not entirely dissociated from soiling is the topic of static electricity, its cause, formation and dissipation. This has been a subject of fundamental interest for some time, and the apparatus used was available for inspection.

Lastly, mention must be made of the work being done on the cotton fibre. In addition to the large amount of co-operative work with the Raw Cotton Commission, Empire Cotton Growing Corporation and other bodies, in which physical and practical tests of cotton, new and old, are carried out, there is

great interest at the Institute and in the industry in the question of instrumentation, and particularly the possibility of forecasting the spinning properties of cotton from physical measurements. Members could see a range of such instruments, including some of foreign manufacture and some made at the Institute. The problem is not an easy one, and indeed may not be completely soluble; but advance has been made, and broad differences in the spinning properties of cotton can now be detected rapidly with the aid of purely physical tests.

OBITUARIES

Prof. H. H. Dixon, F.R.S.

THE death of Prof. Henry H. Dixon on December 20 severs a link with a past generation of botanists and with a classic advance in botany. He was born on May 19, 1869. He was one of a family of seven brothers and two sisters; two of his brothers, and previously his father's brother, were university professors. He had a distinguished career as a student in Trinity College, Dublin, being a classical scholar of some note; he then added to his laurels by obtaining a natural science 'moderators'hip', taking first-class honours, and continued his studies under Strasburger in Bonn, under whom he commenced research in the two major fields to which he contributed so much in later life.

Bonn was a centre of cytological work and, though it is often forgotten now, Dixon was a contributor of some note in the Strasburger school to the work then being done on meiosis. A later paper communicated to the Royal Irish Academy in 1895 was probably the first expression of the view that the appearance of bivalents is due to the approach together of chromosomes, rather than to the splitting of some pre-existent structure, thus giving the first indication of a 'reduction division'. His observation of 'waves of nuclear division' passing across endosperm suggested a mitotic hormone, an observation which has yet to be investigated more fully.

Dixon's interest in cytology and his contributions to it were, however, completely overshadowed by the importance of his work on movements of water and on the status of water, or water relations, in the plant.

His life-long friendship with Prof. J. Joly had, as one of its fruits, the close collaboration between himself, a botanist, and a physicist, and from this emerged the classic theory, spoken of as the 'cohesion theory', to explain the rise of water (sap) in trees and other plants. This hypothesis was developed in the 1890's and extended by notable contributions on the cohesion of water and of sap and by a series of papers on the osmotic relations of plant tissues.

Dixon's originality of mind showed itself in many suggestions which were not followed up in the rather small School of Botany of Trinity College, Dublin. As early as 1892 he had shown how to grow seedlings in sterile culture, and foreshadowed, had the method been developed more fully, the tissue- and root-culture techniques so much used at the present time. He suggested the differential manometer for estimation of respiration-rates in 1902, though he did not develop it as a research instrument. Prof. Dixon also suggested (in a letter in *Nature*) the mutagenic effects to be expected of cosmic radiation, before Müller and the genetical world had come to accept or even consider this view.

In later years his work on transport of solutes and on permeability caused him to suggest hypotheses which, while not accepted later by himself or others, proved to be an effective stimulus both to his own student, Mason, and many other workers elsewhere.

Recognition of Prof. Dixon's qualities came relatively early; he succeeded to the chair of botany in Trinity College in 1904 and was elected to fellowship of the Royal Society in 1908. He was awarded the Boyle Medal of the Royal Dublin Society in 1917 and gave the Croonian Lecture before the Royal Society in 1937. He had been president of the International Botanical Congress and of the Royal Dublin Society, and also of Section K (Botany) of the British Association. He was an honorary fellow of Trinity College, Dublin, an honorary member of the American Society of Plant Physiologists, a Commissioner of Irish Lights and played an active part in many other national and international organizations.

The importance of the School of Botany in Trinity College, Dublin, under his guidance causes one to forget that the staff of this School during sixty years has been only two—the professor and his assistant. No memoir, however short, would be adequate if it referred merely to Prof. Dixon's academic distinction without mention of his very genial personality and of the atmosphere of the School of Botany in Trinity College, Dublin, which he created and which, unfortunately, owing to its small size, so comparatively few of the younger generation of botanists have been able to enjoy.

T. A. BENNETT-CLARK

HENRY DIXON began his university course in natural science under two good men, E. P. Wright, Sir Almroth's uncle, and H. W. Mackintosh, a wonderful lecturer, who looked down his microscope and saw the marvellous works of his Creator. He knew and taught that life begins with a single cell and develops in an orderly manner.

Wright, systematist and traveller, enriched both the Herbarium, which housed Harvey's type specimens of algae, and the lovely Botanic Gardens. Dixon, soon his successor, opened his own professorial sessions with an introduction to the microscope and went on to unicellular organisms. He illustrated the great ideas of evolution and heredity by precise studies in cytology and morphology. No one could escape a knowledge of bacterial and fungal infection, or of elementary ideas in general physiology.

It was my good fortune to begin under Wright and Mackintosh, and to be in Prof. Dixon's first class. I accordingly witnessed the development of his fine course, published as 'Practical Plant Biology' (1922 and 1943). Years afterwards a distinguished surgeon told me that it was the first thing that had really made him think. For the practical classes, which might run to 150, about a dozen demonstrators were taken on.

The successes of later years stemmed from Dixon's careful planning of the School of Botany, opened in 1907, which replaced the few residential rooms in the Front Square. The new Herbarium was added in 1912. The moving of collections and elimination of insects was heavy work. Into the eight-acre Botanic Gardens, moved to Balls Bridge in 1806, Dixon had up to some twenty years ago introduced more than seven thousand species, including Arthur Kerr's notable collection of Siamese orchids which Sidney Wild, the head gardener, tended so sedulously.

No mention of the T.C.D. School would be complete without reference to the red-headed lad, Joe Murray, who appeared in 1905-6 and remained there until his death on January 24 of this year. With the professor, "Joe", Wild and Polly, head of the College groundsmen, I spent many happy years.

The delightful atmosphere of our chief's laboratory could be traced back to the home with his mother and sisters—enlivened by frequent visits from his brothers and their families. It was the same in his own home with his wife, who cared for him with such devotion. I recall his happiness when telling me that their three sons (all of whom have had distinguished careers) had never caused him one moment's anxiety.

W. R. G. ATKINS

Mr. R. S. Whipple

It was with a deep sense of loss that his large circle of friends heard of the death of Robert Stewart Whipple, which occurred at his home in Highgate Village on Sunday, December 13. His father, G. M. Whipple, was superintendent of the Kew Observatory, and was himself very interested in scientific instruments. Thus Whipple grew up with scientific instruments and acquired a love for them which coloured his whole life.

Whipple was educated at King's College School, Strand, and on leaving went in 1888 directly into the Kew Observatory, staying on for three years after his father's death in 1893 with his successor, Dr. Charles Chree. In 1896 for two years he was assistant manager to L. P. Casella, and then he joined the Cambridge Instrument Company, which Horace Darwin in partnership with A. G. Dew-Smith had founded in 1881. In 1909 Whipple and C. C. Mason became joint managing directors. Under their management the firm developed and acquired a high reputation for the quality of its products. Of these, mention may be made of the 'rocking-microtome', a piece of beautiful design by Sir Horace Darwin, and a range of temperature-measuring instruments. Whipple was responsible for the introduction of the Ferry radiation recorder, of which the firm bought the rights for Great Britain. He himself designed an instrument for reading temperatures direct on the gas scale; this is used largely to-day in industry as a sub-standard.

He retired from active management in 1935, but remained a director, and in 1939 was elected chairman of the Board; from this he retired in 1949 for reasons of health, but continued to take a keen interest in the firm. During all this time he took a great personal interest in the employees of the company, which they fully reciprocated, feeling that in him they had a sincere friend.

Whipple was a valued member of the societies connected with physics and a constant attendant at their meetings. He was a member of the Council of the Physical Society during 1909-14 and again during 1925-36, a vice-president from 1914 until 1916 and treasurer from 1925 until 1935. He was president of the Optical Society in 1920-22. He was a founder member of the Institute of Physics in 1920, and served on its Board for a total of twenty-one years between 1920 and 1945, and on its Finance Committee from 1945 onwards. His services in the cause of physics received their highest recognition in his election to the presidency of Section A (Mathematics and Physics) for the Dundee meeting of the British Association in 1939, which, however, was

abandoned due to the outbreak of war—one of the few cases in which that honour has fallen to an industrialist.

Whipple was always interested in the history of science and was a collector of early scientific instruments; of these he built up a wonderful collection which he most generously presented to the University of Cambridge in 1944; but it was not until 1951 that a small building was provided for their display, and the Whipple Museum was opened by the Vice-Chancellor on May 5. Now that "History and Philosophy of Science" has (partly perhaps due to the inspiration of this Museum) been included as a half-subject in the Natural Sciences Tripos, candidates will find the study of the actual instruments, that this Museum affords, of very real help. When the plans for the new Science Laboratories at Cambridge are further advanced, it is to be hoped that a larger building will be found, in which, with the Whipple instruments as a nucleus, the great number of instruments that Dr. R. T. Gunther proved to exist in Cambridge by the collection he was able to get together in June 1936 will again be assembled to grow to a collection worthy of the University.

In addition to the instruments, Whipple gave his library of scientific books, which included many of the rare early ones. He hoped that these might eventually be housed near the instruments, so that an instrument and its description can be studied together.

He also handed to trustees a fund of £3,300—later increased to £8,300—to be used for the purchase of instruments and books.

Whipple was a man of wide interests and engaged in many activities, serving on many committees; these will miss his wise guidance and support—often of a substantial kind. He will long remain in the hearts of those who served with him.

In 1939 he was elected president of the Highgate Literary and Scientific Institution, into which he put new life by his energy and help, and it is now a strong society. Only a little more than a week before his death, he gave the sum of £5,000 to trustees to be used for the benefit of Highgate Village.

Whipple was a fine example of an English gentleman, upright and honourable, full of kindness and sympathy, ready to help in any good cause and a man of wise counsel and sound common sense. He had great charm of manner which endeared him to all with whom he came into contact. He married Helen Muir, daughter of a Glasgow engineer and sister of James Muir, professor of natural philosophy in Glasgow; they celebrated their golden wedding in June 1953. Their son, George, is chairman and managing director of Messrs. Hilger and Watts, makers of optical scientific instruments, and a daughter, Ruth, is the wife of Prof. J. F. Young, professor of pathology in the University of Aberdeen.

R. S. CLAY

We regret to announce the following deaths:

Mr. P. S. Riddale, director of the Charles Lathrop Paik Forestry Foundation, formerly editor of the *American Forestry Magazine* (1912-22) and of *Nature Magazine* (1923-37), on December 23, aged eighty-one.

Mr. H. W. J. Stone, honorary secretary and treasurer during 1933-45 of the Parliamentary Science Committee and editor of its publication *Science in Parliament*, on January 17, aged seventy-six.

NEWS and VIEWS

Royal Military College of Science:

Prof. C. J. Tranter, O.B.E.

PROF. C. J. Tranter has been appointed Bashforth professor of mathematical physics in the Royal Military College of Science, Shrivenham, in succession to Prof. O. G. Sutton, who vacated the chair recently on his appointment as director of the Meteorological Office. Prof. Tranter joined the Ballistics Directorate of the Research Department, Woolwich, in 1931 as a junior assistant, after taking his degree at Oxford, where he had been a mathematical scholar of Queen's College, and his career has been in government service throughout. He joined the Military College of Science, as it then was, in 1935 as senior lecturer in gunnery and mathematics, was promoted to assistant professor in 1941 and during the long illness of the late Prof. Wright was virtually in charge of the Gunnery and Mathematics Branch. Since 1945 he has been head of the Mathematics Branch, and in 1947, after the post-war reorganization of the College, was appointed associate professor of mathematics. During and since the Second World War, Dr. Tranter has been a member of several of the research committees of the Ministry of Supply, and he has published a considerable amount of work, mainly on the application of integral transforms to the boundary-value problems of mathematical physics. Prof. Tranter is a D.Sc. of Oxford and was made an O.B.E. in the Coronation honours list.

Agriculture in the University of Aberdeen:

Prof. A. B. Stewart

DR. ALEXANDER BOYD STEWART has been appointed to the Strathcona-Fordyce chair of agriculture in the University of Aberdeen, in succession to Prof. T. L. Bywater, who has gone to the University of Leeds. Dr. Stewart was educated at Logie Coldstone School, Robert Gordon's College and the University of Aberdeen, where he graduated M.A. in 1925, B.Sc. in chemistry with first-class honours in 1928, and Ph.D. in 1932. After graduating in pure science, Dr. Stewart studied under the late Prof. Hendrick, the first incumbent of the chair to which he now succeeds, and then proceeded to Zurich to work under the late Prof. Wiegner. Returning to Scotland in 1931, he was a research student at the Macaulay Institute for Soil Research and was appointed to the staff in 1932. As head of the Department of Soil Fertility at the Institute, Dr. Stewart developed and extended the work of field experimentation with special reference to the maintenance and improvement of soil fertility. In 1945 he was appointed deputy director of the Macaulay Institute and has since served on numerous technical committees. In 1945, he spent six months in India advising the Central Government on problems of soil fertility and crop production. In collaboration with Dr. F. N. Woodward and the late Mr. J. P. Maxton, he undertook during 1949-51 a survey of agricultural, forestry and fishery products, and their utilization in the United Kingdom. Dr. Stewart has given his services in an advisory capacity to the Forestry Commission and, during 1952, visited the United States of America as a guest speaker. The Macaulay Institute for Soil Research, in parting with him, rejoices in his appointment as a successor of the late Prof. James Hendrick, to whose energy and enthusiasm the foundation of the Institute in Aberdeen was due in large measure.

School of Physics in the University of Sydney

THE previous head of the School of Physics of the University of Sydney was Prof. O. U. Von Willer, who retired in 1946 having held the post for twenty-three years, and the chair was vacant for six years until September last year when Dr. Harry Messel was appointed as the new head. Prof. Messel graduated in Canada from the Royal Military College and Queen's University, Kingston, Ontario, with honours degrees in physics and mathematics, and then went for a year to Scotland (University of St. Andrews), carrying out postgraduate studies in mathematical physics. During the following three years, spent at the Institute for Advanced Studies, Dublin, he took a keen interest in cosmic ray theory, in particular the theory of cascade processes, and it was there that he succeeded in giving an analytical solution for the long-standing fluctuation problem in cascade theory. This work was followed by a series of papers in which he developed the mathematical theory of one- and three-dimensional cascade processes. After a year at Adelaide, South Australia, Prof. Messel was appointed to the chair at Sydney and took energetic steps to establish a large and flourishing research school, concentrating on experimental and theoretical studies of the cosmic radiation and on modern theoretical physics, especially nuclear theory.

Prof. Messel has been joined by Dr. E. P. George from London, who will look after the experimental programme; and further new appointments in the experimental team are Dr. A. J. Herz (London), Dr. D. D. Millar (Manchester) and Dr. H. D. Rathgeber (Melbourne), and, in the theoretical team, Dr. J. Blatt (Illinois, U.S.A.), Dr. S. T. Ma (National Research Council, Canada) and Dr. M. R. Schafroth (Liverpool). A number of further appointments will be made shortly, bringing the number of permanent academic staff in the School to twenty-one. Two students from universities in England are already in Sydney, completing their doctoral training, and a number of postdoctoral Fellows from overseas will be arriving early in the new year. To supplement the limited funds available for research from University sources, Prof. Messel has secured support from Australian business men, with the excellent result that £25,000 is available for research equipment this year, and a similar sum promised annually for the future. This has been secured by setting up a Nuclear Research Foundation within the University of Sydney, which allows private individuals and industries to become members. Experiments are planned on air-showers, underground cosmic rays and spectrum measurements. Theoretical investigations are planned on cascade phenomena, fundamental particles, solid state, etc.

South Wales Laboratories of the British Iron and Steel Research Association: Mr. S. S. Carlisle

WE regret that in *Nature* of January 30, p. 191, it was stated that Mr. D. Luther Phillips was being succeeded as head of the South Wales Laboratories of the British Iron and Steel Research Association by Dr. J. Pearson. This is incorrect; Dr. Pearson is head of the Chemistry Department of the Association and is temporarily taking over the duties of head of the Steel-making Division. Mr. Luther Phillips is being succeeded by Mr. S. S. Carlisle. Mr. Carlisle graduated at The Queen's University, Belfast (College of Technology), in electrical engineering and later continued his studies

at the College, being granted the degree of M.Sc. in 1942. During the course of higher study he was appointed a temporary lecturer in radio and radio-physics at the College. In 1942 he joined the staff of the Director of Scientific Research, Admiralty, and was stationed for four years on H.M.S. *Excellent*, Portsmouth, where he was engaged on the development and trials of radar and gun control equipment, being particularly concerned with the development of electrical predictors. In 1946 he joined the staff of the British Iron and Steel Research Association, and in 1947 was appointed head of the Instrument Section of the Physics Department. Mr. Carlisle has been closely associated with the industry's co-operative work on instrumentation, particularly that of open-hearth furnaces, which has placed Great Britain in the forefront of steelworks instrumentation practice. He is a member of the Council of the Society of Instrument Technology.

Training and Supply of Graduate Teachers In Mathematics and Science

In reply to a request in the House of Commons on January 21 for a statement on the report of the National Advisory Council on the Training and Supply of Teachers with particular reference to graduate teachers of mathematics and science, the Minister of Education, Miss F. Horsbrugh, stated that she accepts the broad conclusions of the report, and that she is consulting the other interests principally concerned to see how the needs of the schools for a better supply of these teachers can best be met. She will also be asking the local education authorities to ensure that the most effective use is made of the graduate teachers of science and mathematics available to them now and in the future.

Threat of Atomic Warfare

READERS of the *Bulletin of the Atomic Scientists* will have noticed that the hands of the clock which forms the distinctive coverpiece of the *Bulletin* have been moved forward so that now they stand at two minutes to midnight. This is to direct attention to the recent announcement that an atomic test involving both fission and thermonuclear reactions was conducted by the U.S.S.R. on August 12 and to warn members of all nations of the great danger of an untoward event acting as a trigger for the eruption of atomic or thermonuclear warfare. In an article in the October number of the *Bulletin* (9, 294; 1953) entitled "The Narrowing Way", the editor, Dr. E. Rabinowitch, expresses the apprehensions which many Americans feel. He considers that unless special care is taken it may only be a few more swings of the pendulum before atomic explosions strike midnight for Western civilization. In 1945 or 1946, he states, the elimination of atomic weapons from national arsenals through an international control mechanism, substituting mutual interdependence for mutual fear, had a slight chance of success, but it now has none and will not until the present cleavage of the world into two sharply opposed power camps disappears. Dr. Rabinowitch maintains that the Western countries are faced with the inevitable prospect of a "cold peace", precariously supported by a mutual threat of atomic and thermonuclear annihilation, and that in order to strengthen this peace it is necessary for the United States of America to create a powerful and universal fear of, and revulsion to, war by presenting to the world a sober account of the present, and reasonable estimate of

the anticipated, destructive capacities of the atomic and thermonuclear weapons in American and other hands. In addition, aggression must be made clearly unprofitable, and, he states, American policy must be directed towards maintaining unity and collective security in the non-communist world.

Linen Industry Research Association: Report for 1953

THE report of the Council of the Linen Industry Research Association for the year ended September 30, 1953 (pp. 20; from the Association, Belfast, 1953), records the completion of the post-war development programme of the Institute laid down in 1945. Membership of the Association now totals 285; but although the grant-earning income increased, the total income decreased slightly through a reduction in the grant from the Flax Development Committee and in the revenue from patents. Promising results have been obtained with a prototype stapling machine for flax fibre, of which the object is to improve levelness during preparing and dry spinning. Investigations continued on productivity in flax spinning, on the drafting of flax and rayon staple fibres on flax machinery with the object of improving the regularity of the yarns, on the elimination of shading effects in plain dyed rayon staple fabrics and on yarn friction. Advances have been made in the use of electronic irregularity testers for routine mill tests for the control of yarn quality, and of the 'Lirna photostubber' to locate the causes of faults in production. In fundamental work on the relation between yarn strength and cloth strength, tests have been completed for cloths ranging in weight from 7 to 12 oz./sq. yd. New instruments have been developed for studying the physical properties of size materials and correlating these properties with performance in the loom. Further advances have been made in producing the crease-resistant finish on linen fabrics, and bulk trials on finishing linen fabrics to improve the wearing qualities are in progress, while a wash-fast flameproof finish applied to linen fabrics has given satisfactory results under user conditions. In moving the adoption of the report and accounts at the annual general meeting on December 11, 1953, the chairman of the council, Mr. H. B. McCance, said that perhaps the greatest contribution the Association has made to the industry has been its unconscious education in the scientific approach, and he referred particularly to the flow of staff from the Research Association to member firms. The director, Dr. A. J. Turner, stressed the plea in the report for greater co-operation from member firms in putting their problems to the Association's staff. He also reported that the experimental work on bleaching linen yarn in package form has now reached the stage of industrial application.

Australian and New Zealand Association for the Advancement of Science

THE report of the twenty-ninth meeting of the Australian and New Zealand Association for the Advancement of Science, held in Sydney during August 1952, edited by J. F. Kefford, has been published (Vol. 29; pp. 386. Sydney: Government Printer, 1953). It includes the presidential address of Sir Douglas Copland on "Authority and Control in a Free Society", and those of the presidents of the several sections, with lists of papers read to the sections and the report of the standing committee of Sections C (Geology) and P (Geography and Oceano-

graphy) on research on eustatic sea-levels in Australia and New Zealand during 1949-52. The sectional addresses include those of Prof. M. L. Oliphant on the research school of physical science in the Australian National University; Prof. A. K. Macbeth on some aspects of the chemistry of monocyclic terpenes; Prof. F. W. Whitehouse on the Mesozoic environments of Queensland; I. M. Mackerras on zoology and medicine; Hon. P. M. Hasluck on the future of the Australian aborigine; Prof. W. Prest on the future of private enterprise; Prof. H. H. Davis on the control of dynamic loading on machine components and structure; E. V. Keogh on virulence and infectivity; Dr. H. C. Forster's review of programmes for agricultural research in Australia; Dr. F. H. S. Roberts on host specificity of livestock parasites in Australia; Prof. V. J. Chapman on problems in ecological terminology; Prof. N. L. Edson on the metabolism of the sugar alcohols; and C. Rudduck on geography and national development. Also published is Dr. J. R. Price's Liveridge lecture on some recent developments in the study of the chemistry of Australian plant products.

Legumes In Agriculture

LEGUMES have been grown as crops for at least six thousand years, though the scientific explanation of their value was not discovered until late in the nineteenth century. How best to incorporate these important plants in the various agricultural systems of the present day is clearly a fundamental question, and, as a step towards providing an answer, the United Nations Food and Agriculture Organization has carried out a review of leguminous plants throughout the world. The report, published under the title "Legumes in Agriculture" (F.A.O. Agricultural Studies No. 21. Pp. 367. Rome: F.A.O.; London: H.M.S.O., 1953; 15s. or 3 dollars), is by R. O. Whyte, G. Nilsson-Leissner and H. O. Trumble. In temperate zones, with ample and well-distributed water supply, wild white clover has become the key factor in ley farming, with subterranean clover as an efficient counterpart in the pastures of South Australia. Little, however, is known regarding the use of legumes in tropical and sub-tropical regions, and literature on the subject is very meagre. In consequence, one of the most valuable parts of the publication is the section giving the results of a questionnaire sent out by the Organization during 1951 as to the occurrence and use of leguminous plants in these parts of the world. The information is conveniently reviewed on a geographical basis, and it may well be that further work on the adaptation and utilization of legumes in the tropics would best be organized on a regional basis. The chief limiting factors appear to be social and economic rather than lack of species, though there is great scope for selection and breeding within existing material. Further, it seems likely that the position of the leguminous crop in the agricultural system will differ from that in temperate lands, the trend being away from a mixed legume/grass association towards a separate but contiguous cultivation. The review should also be valuable as a book of reference, for it includes an alphabetical list of genera with notes on each, tables summarizing the characteristics of herbaceous and shrubby legumes and a bibliography.

A Coniferous Petrified Forest In Patagonia

Two species of fir cones, both of which have been named and incompletely described in earlier publica-

tions, are described with anatomical details by Mary Gordon Calder in "A Coniferous Petrified Forest in Patagonia" (Bull. Brit. Mus. (Nat. Hist.): Geol., 2, No. 2, 97-138; 1953; 12s.). This account is welcome as a full description of a locality where the petrified tree trunks are said to be 100 m. long and 10 m. round; its petrified fir cones have sometimes been sliced, polished and shown in museums as things of beauty. The forest is probably of younger Mesozoic age and was overwhelmed by volcanic ash. Of the two species of cones, one, *Araucaria mirabilis*, is like the Australian *Araucaria bidwillii* but different from the South American species of to-day. Radish-like bodies associated with the cones are recognized as the seedling hypocotyls of an *Araucaria* of this group; they had previously been a mystery. The other cone, with the unfortunate name of *Pararaucaria*, has nothing to do with *Araucaria* but is apparently an extinct member of the Taxodiaceae, its characters being found scattered among the genera of to-day. It is interesting that this family is now absent from South America. It is good to see that two of the many fossil genera assigned to a position between *Araucaria* and *Pinus* have been removed.

Natural History of Bombed Sites

A RECENTLY published illustrated brochure summarizes in a convenient and popular manner the record of colonization of the bombed sites of London by plants and animals ("The Natural History of the City." By R. S. R. Fitter and J. E. Lousley. Pp. 36+13 plates+1 map. London: The Corporation of London, Guildhall, E.C.2; 1953. 2s. net). The introductory chapter is largely a very condensed historical summary of the natural history of the City. It is followed by accounts of the plants, arranged according to their mode of dispersal, and the animals the presence of which is not so obviously connected with the results of bombing. In an appendix all the recorded species are listed. Though the booklet is not intended as a scientific contribution, it gives a good deal of interesting data on ecology and rate of dispersal. Clearly the opportunities to study this unexpected and ill-gotten phase in the City's development will, it is hoped, not long remain; but it is still possible among the ruins to observe rarities in both the plant and animal kingdoms.

British Mammals

SINCE the discontinuation of *The Zoologist* in 1916, the study of mammals in Great Britain has been greatly handicapped by the lack of a specialist journal. It is hoped to remedy this deficiency by publishing in *Oryx* a regular section devoted to the natural history and conservation of British mammals. The twin aims of the section are well illustrated by two articles in the current issue of *Oryx*, one on the field study and identification of British bats, by Michael Blackmore, the other on the case for a close season for deer, by G. K. Whitehead (2, No. 3; November 1953). In addition, it is hoped to publish regularly short notes on matters of general rather than local interest, to review books on or largely devoted to British mammals, and to abstract from local natural history journals any papers or notes of more than local interest. Editors of local journals and secretaries of the mammal sections of local natural history societies and field clubs are invited to send to Mr. R. S. R. Fitter copies of their journals or reprints of any sections of articles relating to

mammals. The address is Drifts, Chinnor Hill, Oxford.

Speech for Deaf Children

RESEARCH in the Department of Education of the Deaf at the University of Manchester has shown that deaf children less than three years old can begin to learn to understand speech through lip-reading as a result of home training by their parents (*Mem. and Proc. Manchester Lit. and Phil. Soc.*, 1952-53). This has been reported by Prof. A. W. G. Ewing, director of the Department, who has discovered that a majority of pupils in schools for the deaf have been found to be deaf from before the age of two. Principles and methods have been evolved which constitute a genetic and simplified approach to speech for the deaf. Investigations which have been taking place over the past twenty-four years have shown that few children are totally deaf and suggest that special nursery schools should be an essential part of educational provision to prevent dumbness. A combination of lip-reading with the scientific use of modern group and individual hearing aids greatly facilitates the development of speech, language and social adequacy by pupils in schools for the deaf.

Boris Kidrich Institute of Nuclear Sciences, near Belgrade

THE rapid growth in recent years of a network of scientific institutions throughout Yugoslavia and, in particular, the establishment and development during the past five years of the three major institutions, the Rudjer Bošković Institute at Zagreb, the Josif Stefan Physical Institute at Ljubljana and the Institute for the Research on the Structure of Matter at Vinča, near Belgrade, was largely due to the efforts of Boris Kidrich. He was a chemist by training, but he devoted himself, as statesman and economist, to the task of the social, economic and scientific development of his country. Boris Kidrich died on April 7, 1953, and in recognition of his work for science the general assembly of the Institute of Research on the Structure of Matter unanimously agreed on April 13 to rename the Institute as the Boris Kidrich Institute of Nuclear Sciences. Accordingly, Vol. 3 (August 1953) of the Institute's scientific publication, formerly *Recueil de Travaux de l'Institut de Recherches sur la Structure de la Matière*, bears the new title *Bulletin of the Institute of Nuclear Sciences "Boris Kidrich"*. In addition to a photograph of Boris Kidrich as frontispiece, it contains nineteen original scientific articles dealing mainly with instruments developed at the Institute for investigations in nuclear physics.

Geography: Journal of the Geographical Association

THIS year the Geographical Association celebrated the sixtieth anniversary of its founding (see *Nature*, January 16, p. 99), and the occasion also marks the diamond jubilee of the Association's quarterly journal, now called *Geography*. A special, enlarged jubilee issue has been published which contains several papers on the work and history of the Association by T. O. Warrington, H. J. Fleure, O. J. R. Howarth and others. Founded by B. B. Dickinson, H. J. Mackinder, A. J. Herbertson, H. R. Mill and others for furthering the study of geography on a scientific basis in schools and universities, the Association has grown to be an organization of several thousand members with branches in many countries. Its journal once chiefly contained papers on teaching

and method, but now it has developed into a leading publication in geographical research. The Association has in turn moved its library from Oxford, Aberystwyth and Manchester, and is now, by courtesy of the City Corporation, housed in Sheffield in a branch of the City Library.

Ergonomics Research Society: Annual Conference

THE fourth annual conference of the Ergonomics Research Society will be held at Ashorne Hill, near Leamington Spa, Warwickshire, during April 5-8, under the chairmanship of Sir Frederic Bartlett, formerly professor of experimental psychology in the University of Cambridge. The conference will be opened by Sir George Barnett, H.M. chief inspector of factories, and the speaker at the closing session will be Dr. Leonard Carmichael, secretary of the Smithsonian Institution, Washington, D.C. The annual general meeting of the Society will be held on April 6. The conference will be open to non-members of the Society on payment of a fee of 30s. All those wishing to attend the conference, whether members or otherwise, must complete an application form by March 29 and return it to K. F. H. Murrell, "Spinneys", Marlpit Lane, Redditch, Worcs, from whom further information can be obtained.

Acoustics of Orthoptera: Symposium near Paris

A SYMPOSIUM on the acoustics of Orthoptera, the first of its kind ever to be organized, will be held near Paris in the Laboratoire de Physiologie Acoustique, Institut National de la Recherche Agronomique, Jouy-en-Josas, Seine et Oise, during April 5-8. The fields to be covered will be as follows: acoustic emission in Orthoptera (standardization of definitions and of physical acoustics applied to the emissions, techniques of recording, techniques of physical analysis, mechanisms of emission, emission behaviour, and techniques of artificial reproduction of the sounds); acoustic reception in Orthoptera (physiological analysis of reception (action potentials) and reception behaviour); behaviour of Orthoptera under artificial acoustic stimuli; and bibliography. Besides the usual short papers and contributions, the following specialists will give general reviews on certain topics and reports on the work which is being done in their respective countries: Germany, Prof. H. Autrum (University of Würzburg) and Prof. W. Jacobs (University of Munich); Great Britain, Prof. R. J. Pumphrey (University of Liverpool); Italy, Prof. E. Benedetti (University of Parma); and United States, Prof. H. Frings (Pennsylvania State College). The languages for the symposium will be French, English, German and Russian. Further information can be obtained from the Laboratoire de Physiologie Acoustique at the above address.

Announcements

PROF. H. H. READ, professor of geology in the Imperial College of Science and Technology, London, and Prof. Louis Royer, professor of mineralogy and crystallography and dean of the Faculty of Sciences of the Institut d'Hygiène et de Médecine d'Outre-Mer de l'Afrique du Nord, have been elected *correspondants* for the Mineralogical Section of the Paris Académie of Sciences in succession to the late Prof. A. Bigot and Prof. P. Niggli.

THE thirty-eighth Guthrie Lecture of the Physical Society will be given by Sir Geoffrey Taylor in the Science Museum, Exhibition Road, London, S.W.7,

on March 26 at 5 p.m., his subject being "Diffusion and Mass Transport in Tubes". The Lecture is open to the public.

FOLLOWING the annual general meeting of the Textile Institute, Manchester, to be held at The Queen's University, Belfast, on April 30, Dr. D. A. Clibbens, until recently head of the Chemistry Division of the British Cotton Industry Research Association, will deliver the Mather Lecture for 1954, his subject being "Cellulose Chemistry and the Textile Industry". The Mather Lecture, first delivered in 1919, is held in memory of Sir William Mather, president of the Institute during 1915-17.

THE Histochemical Society will meet at Atlantic City, New Jersey, during April 16-17, following the session of the American Society for Experimental Pathology. A feature of the meeting will be a symposium on "Basophil Components of Cytoplasm", to be held on the afternoon of April 16. Further information can be obtained from the secretary of the Society, Dr. R. D. Lillie, Department of Health, Education and Welfare, National Institutes of Health, Bethesda 14, Md.

A CONFERENCE on "Unit Processes of Oxidation", arranged jointly by the Institution of Chemical Engineers, the Chemical Engineering Group of the Society of Chemical Industry, the Chemical Engineering Group of the Koninklijk Instituut van Ingenieurs (Royal Institution of Engineers) and the Section for Chemical Technology of the Koninklijke Nederlandse Chemische Vereniging (Royal Netherlands Chemical Society), will be held in The Hague during May 6-7, with a third day reserved for excursions. Particular stress will be laid on the chemical engineering aspects of unit processes of oxidation. The conference language will be English. Further information can be obtained from the secretary of the British organizing committee, R. O. Odams, Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1.

THE Spectrochemistry and Colorimetry Group of the Austrian Chemical Association is holding its fifth international colloquium in Grunnden (Salzkammergut) during August 30-September 3. As in former years, the colloquium will be divided into two parts, absorption and emission spectroscopy; for the former, the theme will be the application of molecular spectroscopy to the examination of technical artificial fibres, and for the latter, the discussion will deal chiefly with non-conductors and the alloys of copper. Interested organizations from other countries are invited to attend and should write before the end of March to Arbeitsgruppe für Spektrochemie und Kolorimetrie im VOCh, Wien IX, Sennengasse 2 (Institut für gerichtliche Medizin). Each national organization will be allowed to submit five papers, and short summaries of these should be sent in by May 30.

THE Atomic Energy Research Establishment, Harwell, is holding a second radioisotope conference in Oxford during July 19-23. The conference will be concerned with medical applications (including therapy and diagnosis), biological applications (including agriculture and biochemistry), chemistry and metallurgy, and physics, engineering and industrial applications. The last date for applying for membership at the normal fee is February 28, after which a late fee will be payable. Application forms and

further information can be obtained from the Conference Secretary, Second Radioisotope Conference, A.E.R.E., Harwell, Berks.

THE second (October 1952; 18 papers), third (December 1952; 23 papers) and fourth (March 1953; 28 papers) lists of scientific reports produced by members of the Atomic Energy Research Establishment, Harwell, and now available for sale at H.M. Stationery Office are published in the *Atomic Scientists' Journal* (3, No. 1, 58; 1953). They include bibliographies on americium, fission, the electrostatic separation of minerals, and the drying of gases and determination of moisture in gases, and reports of symposia on thin films and the handling of radioactive and toxic substances. The reports bear dates between July 1949 and November 1952.

APPLICATIONS are invited for Lady Tata Memorial Fund grants, scholarships or fellowships to scientific workers of any nationality for research on diseases of the blood, with special reference to leukaemia or any aspect of malignant disease connected with leukaemia, during the academic year beginning on October 1 next. Grants are made for research expenses; scholarships are awarded as personal remuneration, their normal value being £800 a year for whole-time research; and fellowships are for workers with considerable research experience, the stipend being £1,000 a year. Applications must be submitted before March 31, and the awards will be announced in June. Application forms and further information can be obtained from the Secretary of the (European) Scientific Advisory Committee, Lady Tata Memorial Trust, c/o Medical Research Council, 38 Old Queen Street, London, S.W.1.

THE Medical Research Council is offering a number of fellowships for the academic year 1954-55, as follows: *Rockefeller travelling fellowships in medicine* (2,700 dollars a year, or 3,600 dollars for married men) for graduates resident in Great Britain with previous research experience in clinical medicine or surgery, or in some other branch of medical science, to work at a centre in the United States or elsewhere abroad before taking up positions for higher teaching or research in Britain; *Elis Lilly travelling fellowships in medicine*, of a similar nature to the Rockefeller awards; and *Dorothy Temple Cross research fellowships in tuberculosis* (£850 a year, or £900 for married men) for British subjects to devote themselves to the advancement of knowledge of tuberculosis at a centre outside Great Britain. All these fellowships carry, in addition, an allowance for travelling and other expenses. Application forms (to be returned by March 15) and further particulars can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, Westminster, S.W.1.

"METHODS OF THEORETICAL PHYSICS", by Prof. P. M. Morse and Prof. H. Feshbach, was advertised in *Nature* of January 16, p. v. The McGraw-Hill Publishing Co., Ltd., McGraw-Hill House, London, E.C.4, has asked us to state that the price of these volumes is £8 each; Part 2 consists of pp. 998-1978 of the complete work.

ERRATUM.—In the communication "Distribution of Radio-Frequency Brightness across the Solar Disk and the Derivation of a Model Corona", by P. A. O'Brien and O. J. Bell, in *Nature*, January 30, p. 219, the units of the distance from the centre of the disk in the graph for $\lambda = 1.4$ m. should be 0, 0.5, 1, 1.5 and not 0, 1, 2, 3 as printed.

EUROPEAN ASSOCIATION OF EXPLORATION GEOPHYSICISTS

MEETING IN MILAN

THE fifth meeting of the European Association of Exploration Geophysicists was held in Milan during December 2-5, when about a hundred and ten members were present, the president, D. T. Germain-Jones, being in the chair. After discussing affairs of business, the chairman announced the recent deaths of two founder members, M. Schlumberger and K. Röpke, and called the meeting to pay tribute to their memory: Marcel Schlumberger was internationally famous for his development of electrical measurements in boreholes which are, to-day, routine in the oil industry throughout the world; Karl Röpke was one of the early workers, under Prof. Mintrop, with the seismic refraction method of prospecting.

Of the twenty-two papers presented, eleven were on seismic, six on gravity, three on electrical, one on magnetism and one on general problems in exploration geophysics. R. Cassinis and E. Carabelli (Italy) opened with an account of a reflexion and refraction survey for thickness determination over the Del Forni glacier in the Italian Alps. Such investigations have a direct bearing on the exploitation of hydro-electric power, largely for the distribution of water for farming purposes, and large-scale surveys have already been carried out over the Swiss and French glaciers. A most disconcerting feature is that the number of glacial reservoirs has notably decreased in the past few years. By way of extreme topographic contrast, T. F. Gaskell (Great Britain) described the measuring technique and the results of the refraction surveys in the Atlantic, Pacific and Indian Oceans as part of the scientific programme of H.M.S. *Challenger* during 1950-52. An account of this seismic work has recently been published¹.

Three papers related to velocity measurement. The first, by F. Haastadik (Germany), implied that seismic computers are too apt to use continuous velocity/depth functions even when finite velocity changes are known to exist; but, in the discussion, several speakers refuted such a sweeping assertion. J. G. Hagedoorn (Holland) compared the vertical velocity measurements in a borehole with the bedding velocities obtained by refraction, but pointed out that dispersion might be greater for the much greater travel distances of the refracted impulses and, therefore, that these impulses would travel with a lower frequency and higher velocity. This would invalidate to some extent any conclusions as to anisotropy, while another adverse factor is that it is not possible to say explicitly what thickness of the refractor is traversed by the refracted (actually diffracted) wave in the bedding direction. The third paper, by J. Cholet and H. Richard (France), approached this matter of anisotropy in a more direct way. They measured travel times along various paths inclined up to 50° with the vertical and showed that a coefficient of anisotropy of 1.09 for clays and sands would compensate for the discrepancies of travel time observed.

On the theoretical side, M. Matichinski (France) proposed a simple but sufficiently exact method of dealing with elastic hysteresis in the propagation of seismic waves with particular reference to absorption, while T. Krey (Germany) presented three-dimensional formulae for the correction of the position of the

reflector for any refraction to which the reflected wave had been subjected.

The drilling of shot holes often poses difficult mechanical problems depending on the softness or hardness of the formations, the tendency for the walls of the hole to cave in and the loss of fluid circulation. G. Muratori (Italy) discussed the overall practical aspects and design details of the drilling machinery adopted in these various conditions; they included drills operated by high-pressure water jet, conventional rotary and percussion drilling and the very efficient diesel hammer especially suitable for the gravels and boulders of the Po valley.

It may seem surprising that, after a generation of seismic prospecting, the mechanism of the explosion and energy transmission at a shot point are imperfectly understood. The difficulty lies in the large number of controlling factors and the well-known requirement that a set of shot-point conditions is not entirely reproducible for check purposes. This situation was rendered more complicated by V. Colledan and A. M. Salem (Italy), who demonstrated that, with equal weights of an ammonium nitrate dynamite (sismite) and a nitro-glycerine dynamite (GDIMT), reflexion responses were greater for the former despite its 30 per cent lower strength and lower detonation velocity than the latter. Other explosives were also used in the test; but conclusive results cannot be given until many more experiments have been done; the results will be of some importance, as the ammonium nitrate explosives are much safer to handle in some climatic conditions than the nitro-glycerines. The safety factor in seismic work was further discussed by E. Merlini and A. M. Salem (Italy) in cases where the detonator circuits pass close to power lines, electric railways or deep well casings. The induced potentials set up in certain types of ground, especially during electrical storms, might result in premature ignition of the explosive unless precautionary disposition of the detonator leads is resorted to.

The final paper in the seismic session, given by L. Solaini and G. Uglietti (Italy), described an electronic blaster with a codified radio transmission of the shot instant designed to prevent 'noise' which may impair the received signal when using other blasters; all the usual operations from stand-by to shot-instant transmission are automatically provided for.

Contributions to gravity interpretation were made by three members. A. Marussi (Italy) discussed the meaning of the second differential parameter and adduced formulae relating it to the curvature and normal gravity derivatives. V. Baranov and J. Tasseaucourt (France) gave a mathematical exposition of certain approximations made in a paper on a practical method of calculating the vertical gradient which the first author had given at the Paris meeting of the Association. The vertical gradient and second derivative methods were applied by O. Roenbach (Germany), who showed how it is possible to locate a well on the down-throw side of a fault, given the depth of the up-throw side, other geophysical methods having failed.

A most interesting account of gravity measurements in the northern Adriatic Sea was given by O. Morelli (Italy). Here a tele-controlled Western

gravity meter, enclosed in a bathysphere weighing about half a ton, is lowered to the sea-bed, its position being fixed by radar intersection from fixed reflectors on land and at sea. The accuracy of measurement is estimated to be ± 0.05 mgal. The technique is, of course, several years old, but an important refinement in the new equipment is the inclusion of a compensator for microseisms, or seabed movements of relatively long period.

The meeting devoted some little time to the important subject of terrestrial tidal variation of gravity in precision studies, and, as the past president of the Association, A. van Weelden, had played a big part in initiating world-wide experiments to improve our knowledge in this respect, he was invited to take the chair for this section of the meeting. O. Morelli (Italy) reported on an extension of his diurnal investigations discussed at the Paris meeting and showed that curves calculated for northern Italy, lat. 45° N., long. 12° E., are applicable for all longitudes if times are suitably corrected. The curves yield an accuracy of 0.01 mgal. within 2 deg. of latitude. Extension to 13 deg. beyond this range also gives the same accuracy on multiplying the amplitudes by a suitable factor. M. Cuniatti and G. Inghilleri (Italy) provided a general analysis of the accuracy of the curves for any one station and proposed that the terrestrial tide be derived from an expression of the form:

$$\Delta g = F_1 \sin^2 \varphi + F_2 \sin 2\varphi + F_3,$$

where the constants, which are functions of the local hour angle and declination of the moon and sun, would be periodically determined and published. R. Tomaschek (Great Britain) discussed solutions which, by needing only little computing work by a survey party in the field, would avoid the necessity of making periodical calculations in a central institute. He advocated the use of permanent curves for the sun and the moon and a simplified current noon ephemeris of the moon.

J. Goguel (France) then reported the conclusions of the Tidal Committee, consisting of himself, O. Morelli and R. Tomaschek. They recommended publication in *Geophysical Prospecting*, the journal of the Association, of two kinds of tidal corrections for 1954, which should be tested by field parties as to their simplicity. The first kind consists of curves showing the continuous variation of the tidal forces for several selected latitudes, and the second consists of tables. Each is expressed by:

$$\Delta g = -A + N(\cos \varphi + \sin \varphi) \cos \varphi + S(\cos \varphi - \sin \varphi) \cos \varphi,$$

where φ is the latitude and N and S time functions of the moon and sun together. The tables are obtained by means of a tide predictor. By using a simple nomogram the tidal correction may be determined by means of N and S for any latitude.

O. Morelli and L. Sogaro (Italy) described the results of a magnetic survey designed to investigate the trend of the volcanic outcrops in the Lessini, Berioi and Euganei uplands as they disappear beneath the Venetian plain towards the Adriatic Sea. Two branches are apparent, one towards Venice and the other towards Chioggia.

In the electrical section J. J. Breusse and G. Huot (France) illustrated how, in the course of exploring for water, four hundred depth measurements mapped the top of a clay formation underlying the alluvium of the Catania plain (Sicily). The map showed the presence of an old river valley system which was

believed to be filled with permeable alluvium; five wells drilled over these channels were productive. The problem of electrical sounding in the case of dipping plane interfaces is usually approached through an approximate application of the electrical image method for horizontal interfaces. A few years ago, however, an exact but laborious solution of the general problem was formulated. This has recently been improved on by J. Chastenat de Gery and G. Kunetz (France), who illustrated their analysis with interpretation charts. A most informative paper was that given by J. L. Mathieu (France), who described the 'laterolog', a method for better recording of formation resistivity in boreholes. Here, a current of constant intensity is forced into the formation perpendicular to the wall of the hole as a sheet of predetermined thickness by means of a special electrode arrangement, the control system being automatic. The many advantages of the 'laterolog' over ordinary resistivity logs were explained and illustrated by numerous examples.

The one general paper, by O. Vecchia (Italy), discussed the application of electrical and seismic refraction measurements in the problem of building a subsidiary dam on the Lake of Molveno, near Venice. The depth to bedrock was given by refraction, while the permeable nature of the overlying detrital matter was determined by electrical measurements at a number of water-levels. The results showed that subterranean losses disappeared when the level of the lake was 160 ft. lower than normal.

The technical proceedings closed with three films: "Schlumberger Surveys", presented by courtesy of the Société de Prospection Électrique, Paris; and "Recording the Safe Way" and "Drilling the Safe Way", both by courtesy of the Society of Exploration Geophysicists, United States. A short report of the Committee on Safety, given by A. van Weelden, made it very clear that lively action has been and will be taken on this important facet of applied geophysics.

All the arrangements for the meeting were efficiently and generously made by A.G.I.P. Mineraria, which also organized a visit to their geological and geochemical laboratories and to a seismic party; here, a comparative demonstration of rotary and percussion drilling by winch and diesel hammer was most impressive. On the lighter side, sight-seeing tours were arranged by A.G.I.P. for members' wives and for members themselves when their otherwise arduous duties were over, and the Fondazione Ing. Lerici gave a cocktail party. The next meeting of the Association will be in Copenhagen in the late spring of this year.

T. O. RICHARDS

¹ *Nature*, 167, 723 (1951), and 170, 1010 (1952); *Petroleum Times*, 87, No. 1470 (1953).

MATHEMATICAL ASSOCIATION

ANNUAL MEETING

THE annual meeting of the Mathematical Association was held at King's College, London, during January 4-6, with the president, Prof. T. A. A. Broadbent (Royal Naval College, Greenwich), in the chair. In his presidential address, "Printer's Ink and the Teacher", Prof. Broadbent, who has edited the *Mathematical Gazette* since 1930, drew on this experience to offer two main suggestions to the teacher of mathematics. First, mathematics is a language, the

language of abstract, rational thought, and the teacher who wishes to train his pupils in this language must first be master of his own mother-tongue; good mathematics and clear, simple English go together. Secondly, the teacher must use periodical literature in mathematics to keep in touch with some part, however small, of current research, so as to be able to present school mathematics to his pupils as an essential element of a living, growing organism.

In the afternoon of January 4 the meeting discussed the report of the Association on the teaching of sixth-form geometry. The report recommends a first course, including all that can be regarded as suitable for every pupil who takes mathematics as a main subject after he begins to specialize in mathematics, science or engineering, and a second course, suitable only for mathematical specialists, in which the beginnings of abstract projective geometry could be studied, thus rendering less abrupt the transition from school geometry to university geometry. The discussion was opened by Prof. E. H. Neville (University of Reading), the chairman of the committee which drew up the report, and by Mr. H. Miller (Watford Boys' Grammar School). In the open discussion members recognized the high importance of the report, but suggested that some years would have to elapse before its recommendations could be digested and applied. In the evening of the same day, the principal of King's College, Mr. P. S. Noble, spoke on 'Euclid the Artist'. Mr. Noble, as a distinguished classical scholar, sees Greek geometry as an integral part of Greek thought and art, and, after sketching its growth from Thales to Apollonius, he compared mathematics with other typical products of the Greek genius, in its essential simplicity, logic and beauty. As a particular instance, a detailed comparison with Greek forensic oratory was drawn.

The proceedings on January 5 opened with a discussion between Mr. J. Kershaw (College of Building, Liverpool) and Dr. C. W. Jones (University of Liverpool) on 'Numerical Analysis'. Mr. Kershaw outlined a course in numerical analysis for engineers, and Dr. Jones commented on the points raised, the general content of the syllabus and details of method. This interchange of ideas proved very instructive, and the Association hopes to stage a more elaborate version of such a debate at a later meeting. Mr. O. T. Daltrey (Institute of Education, London) spoke next on 'Teaching through the Flash of Insight'. There is a logico-psychological conflict in the learning of mathematics, which may be resolved through teaching in accordance with Nunn's doctrine of the growth of mathematics from problem to process. 'Gestalt' psychology suggests that the problem must be seen as a whole, with a structure transcending the related parts; genuine learning ensues when this view of the problem leads to 'the flash of insight'. All teaching, said Mr. Daltrey, must be directed to the encouragement of individual insight and personal creative activity.

A discussion on 'Unified Mathematics as a Factor in Education' was opened in the afternoon of January 5 by Mr. K. R. Imeson (Sir Joseph Williamson's Mathematical School, Rochester), Miss W. A. Cooke (High School, Slough), Mr. K. B. Swaine (Yeovil School) and Miss K. M. Sowden (City of Bath Training College). 'Unified' mathematics may mean a combined course or a method of teaching. The speakers found the second aspect the more important, and suggested a number of topics which could be grouped around one fundamental mathematical

principle. Other matters of debate were the provision of combined or separate text-books, and the relevance of the method to pupils at different stages. In the open debate, details were criticized, but there seemed to be no definite verdict in favour of the 'unified' course.

The last paper was given by Dr. E. A. Maxwell (Queens' College, Cambridge), on 'The World Around Us', in which, by a survey of the "General Knowledge" questions set by the scholarship groups of the University of Cambridge during the past fifty years, he depicted the examiner as historian, artist and sociologist. Delicate textual criticism enabled Dr. Maxwell to make substantial contributions to the study of 'Examinio-Deuteronomy', 'Examinio-Genesis' and 'Examinio-Revelations'.

The president of the Association for 1954 is Prof. W. V. D. Hodge, Lowndean professor of geometry in the University of Cambridge.

BROADCASTING AND TELEVISION IN GREAT BRITAIN

AT the meeting of the Institution of Electrical Engineers on October 8, Mr. H. Bishop, director of technical services of the British Broadcasting Corporation, gave his inaugural address as president of the Institution for the current session. The major part of the address comprised a most useful and opportune review of the development of broadcasting and television with special reference to the services of the B.B.C., and to the need for international co-operation. While those engaged in most branches of engineering have much to gain by the exchange of information and experience with their contemporaries in other countries, the radio engineer has a special need for international agreement since radio wave propagation cannot be restricted to national boundaries.

In just over thirty years, broadcasting has been built up from nothing in all the important countries of the world; and several international organizations are now constantly concerned in seeking solutions to the problems which accompany the development and operation of home and overseas services. These problems include the allocation of frequencies in parts of the radio spectrum long since overcrowded, and the application of standardization to facilities for the exchange of programmes and the control of interference.

Some idea of the complexity of the problem of broadcasting on low and medium frequencies, on which most national home services at present depend, may be gathered from figures given by Mr. Bishop illustrating the growth of broadcasting in Europe. In 1929 there were two hundred stations in operation occupying a band-width of 1,014 kc./s.: as a result of a European Regional Conference at Copenhagen, a 'plan' came into operation in 1950 under which 243 stations were allocated frequencies which filled the total available band of 1,215 kc./s. Three years later, the number of stations in operation had increased by 50 per cent; and as a result, all stations, including those of the B.B.C. in Britain, are liable to suffer serious interference. An indication of the corresponding growth of world broadcasting is given by the fact that the total number of sound receivers in all countries rose from 20 million in 1929 to more

than 200 million in 1953; the latter figure corresponds to one receiver for every twelve persons in the world.

The dearth of frequencies and the continued increase in the number of stations present a serious problem in the maintenance of a home sound broadcasting service in the low- and medium-frequency bands; and there is little prospect of resolving this problem by an increase in power or improvement in aerial efficiency at transmitting stations. The high-frequency band (3-30 Mc./s.) is not suitable for local services, and now has its own very serious problems for external broadcasting to countries overseas. In pursuance of the present policy of the B.B.C. of providing for the national coverage of three sound programmes, it is therefore proposed to inaugurate home broadcasting services in the very-high-frequency band of 88-95 Mc./s. Considerable experience has been obtained by the B.B.C. in this band with an experimental station at Wrotham in Kent, erected in 1949; and it is now planned to build fifty-one stations at nineteen locations to provide for the Home, Light and Third Programme Services. The building of these new very-high-frequency stations will take several years, and additional transmitters may be added later to complete the national coverage.

With reference to television broadcasting, Mr. Bishop first reviewed the considerations that resulted in the decision to reopen, in June 1946, the London television station, which provided a regular public service from November 1936 until the outbreak of war in September 1939. This has resulted in the development of the television service in Britain on the basis of the pre-war transmission standards of 405 lines, with double interlaced scanning at a picture frequency of 25 per sec. In the light of developments since that time, there is no doubt that this was the right decision. The subsequent installation of additional high- and medium-power transmitters in the United Kingdom has been accompanied by technical developments which have enabled a steady and considerable improvement in picture quality to be obtained with the band-width limitations imposed generally by the radio and cable links between the television transmitters and the studio at which the programme originates. While the present plans of the B.B.C. are concerned with providing national coverage to the extent of 98 per cent of the population for a single programme, the Corporation has also under consideration the need for providing an alternative television programme on a nation-wide basis. Such alternative services, together with any competitive programme service the Government may decide to introduce, will have to be transmitted in various bands of frequencies between 174 and 960 Mc./s. A large amount of research on various aspects of the use of these frequencies is in progress in anticipation of such developments. It is in these bands, also, that any system of colour television will have to be accommodated. In this connexion, Mr. Bishop stressed the importance of ensuring that any colour system introduced must be compatible with the present black-and-white system. This means that the colour transmissions must be such that they provide for the reproduction of a black-and-white picture on the two and a half million receivers already in use in Britain, without any modification of the band-width or other features of these receivers. It may, of course, be necessary to add an adaptor to such receivers to enable them to be tuned to the transmissions in the higher-frequency bands; and

this and other matters are already receiving attention by those engaged in the radio receiver industry.

In the concluding portion of his address, Mr. Bishop referred to the fact that the rate of growth of membership of the Institution, which is about 38,000, appears to be decreasing. While this is not necessarily a bad thing, it might, he suggested, be associated with the problem of maintaining a sufficiency of recruits to the electrical engineering profession. He suggested that it is time to make a fresh assessment of the needs of the profession and the manner in which these could be met by stimulating the appropriate class of education in schools and universities.

NATIONAL RESEARCH DEVELOPMENT CORPORATION ANNUAL REPORT FOR 1952-53

THE report and statement of accounts of the National Research Development Corporation, covering the year ended June 30, 1953*, is the last which will appear before the Corporation's borrowing powers expire at the end of next June. Although the Development of Inventions Act, 1948, which established the Corporation, empowered the Board of Trade, with the consent of the Treasury, to make advances of up to £5 millions for the capital expenditure of the Corporation in connexion with the development and exploitation of inventions, only 10 per cent of that amount has been used by the Corporation for the development of new inventions during its first four years. A statutory function of the Corporation is to secure, where the public interest requires, the development or exploitation of inventions resulting from public research, and of any other invention which it appears to the Corporation is not being, or is being insufficiently, developed or exploited. Of the fourteen development projects currently in hand, five are derived from private sources. The great majority of the public inventions either require no development or are of such a character that industry, when interested, is prepared to accept the risk of development.

The activities of the Corporation in connexion with requests for assistance for development during the past four years thus suggests that within its statutory responsibilities the need for assistance is much less than was anticipated when the Corporation was established. As a result of these four years of working the Corporation is now a party to more than two hundred and fifty licence agreements with industry in the United Kingdom or abroad, and to revenue-sharing agreements with universities, university research workers and industrial research associations. The administration of 2,224 patents and patent applications in the United Kingdom and overseas thereby involved is a continuing commitment for the Corporation in respect of wasting assets with a maximum life of about sixteen years. The Corporation is also required to seek to recover its expenditure by licensing firms engaged in the industry concerned so as to use the inventions which the Corporation administers. Revenue from recurrent royalties has steadily increased, that for 1953 being £21,204, whereas that from paid-up royalties

* National Research Corporation. Report and Statement of Accounts for the Year 1st July 1952, to 30th June, 1953. Pp. ii+18. (London: H.M. Stationery Office, 1953.) 9d. net.

for premium royalties or options is necessarily irregular from year to year, and in 1953 was no more than £2,129 compared with £3,029 in 1950.

As regards development projects, electronic digital computers were still the largest single commitment. Commercial orders, including one for export, have been received for three of four large machines similar to that designed by Prof. F. C. Williams in the University of Manchester, and deliveries were scheduled to be made during 1953-54. The prototype of a smaller machine has been temporarily installed in the Mathematical Laboratory at Cambridge for trials. Development of the Packman potato harvester during 1952-53 was concentrated on the criteria necessary for a successful potato harvester as stated by the judges in the open competition of the Royal Agricultural Society of England. Development of the inventions in the field of hydrocarbon synthesis at the Imperial College of Science and Technology, London, proceeded without setbacks; but rapid progress was not at that time expected. Prototypes of a light steam-engine were being developed to suit the findings of a market survey in India and Pakistan. Development on both the aural microscope and the chick sexer was completed during the year, and a substantial number of chick sexers were sold in Britain and abroad.

Results of the pilot-scale production in East Africa of hecogenin from sisal juice have encouraged further contracts for supplies; the crude concentrate was being purified in the United Kingdom and pure hecogenin acetate was being made available for the synthesis of cortisone. Prototypes of the Burns inhaler for the administration of tritene and other volatile anaesthetics were about to be delivered for clinical trials. Resin-based formulations containing insecticides have been the subject of patent applications in the United Kingdom and of overseas and licence agreements made with several British paint manufacturers. Commercially produced formulations are becoming available on an increasing scale. Increased interest in a group of some thirty inventions in the plastic structures field, which originated in the Royal Aircraft Establishment, Farnborough, is attributed to growing realization of the importance of phenolic-impregnated asbestos felts as constructional materials, and polyurethane and furan resins for foams and adhesives, respectively. A special study of the process of shock-curing of plastic laminates was being carried through so that the results could be made available to industry, and the construction by the Corporation of a plastic structures demonstration laboratory was proposed. The prototype of a novel machine for the liquefaction of atmospheric gases on a scale considerably smaller than that of conventional machines, invented at the University of Reading, was being built, and a programme of development of a regenerative system of mechanical transmission, known as the 'Gyreasts' system, has been inaugurated. This is of particular application to public-service vehicles.

Of the 692 inventions communicated to the Corporation during the year, 273 were from Government departments and research councils, 6 from industrial research associations, 16 from Commonwealth official organizations, 48 from universities and 314 from British private firms and individuals. Of the 257 patents or patent applications, the assignment or transfer of which to the Corporation was registered during the year, 185 were from Government departments and research councils, 22

from industrial research associations, 36 from universities and 11 from British private firms and individuals. Of the Corporation's total holdings of patents and patent applications at June 30, 1953, 501 were United Kingdom granted patents and 498 United Kingdom patent applications, the corresponding overseas figures being 227 and 998, respectively.

IMPERIAL FORESTRY INSTITUTE, OXFORD

ANNUAL REPORT FOR 1951-52

THE annual report of the Imperial Forestry Institute, University of Oxford, for 1951-52* shows that the Institute has expanded beyond all recognition from its early beginnings at the inception of the late Lord Lovat, the first chairman of the Forestry Commission. The idea then, as it still is, was to give postgraduate courses to forestry graduates who had been nominated as forestry probationers by the Colonial Office, and to offer refresher courses to members of the Colonial Services on leave. This latter course was attended during the year under review by sixteen forest officers from Nigeria (five), Gold Coast and Tanganyika Territory (two each), and Sierra Leone, Northern Rhodesia, Uganda, British Guiana, Trinidad, Fiji and Sarawak (one each). In addition, an Indian forest officer (Bengal) and one Pakistani forest officer (Punjab) attended the course arranged for them. As evidence of the wide nature of the courses offered at the Institute, five forest officers (Gold Coast, Nigeria, Trinidad and Sudan) attended a special aerial survey course during the Michaelmas term. In addition, the silviculturist from the Agricultural Research Institute, Wad Medani, Sudan, and a German student from the forestry school of Göttingen attended the Institute for periods. It is of interest and importance to learn that nine students successfully sat the Final Honours School of Forestry. Of these, one Ceylon scholar took up a post in his country, another Gold Coast scholar took a post in the Gold Coast Forest Service, a third forestry scholar has returned to Uganda and two of the others obtained posts in the Colonial Forest Service.

The importance of the wide departure from the original conception of the Institute may lie in the future with the changing administrative policies in the British Colonies. Although little alluded to, forestry must play an important part if the forest services are eventually to be managed by the native administrations concerned. It is not possible, at present at any rate, to train fully the officers required for the higher forestry administrative posts in the Colonies. A final course in Europe may be regarded as indispensable to study European forest management which has been in force for so long a period. At the Institute such advantages are provided and other facilities are available to give the final training. For this reason alone the future importance of the Institute cannot be too strongly emphasized. The report deals fully with the various lecture courses given and the practical courses in the forests of France, Switzerland and Denmark, and also in Great

* The Imperial Forestry Institute, University of Oxford. Twenty-eighth Annual Report 1951-52. Pp. 23. (Oxford: Holywell Press, Ltd., 1953.)

Britain in both Forestry Commission areas and on private estates. Advantage can be taken of courses in every branch of forestry, including saw mills and utilization generally, soil science and other research.

The staff of the Institute, excluding the office and library members, now numbers fifteen, including Prof. H. G. Champion, the head of the Institute, with five others from university departments who assist in instructional work. An excellent reproduction of a drawing of the Institute building, by Alan Course of the *Oxford Mail*, is given as a frontispiece.

E. P. STUBBS

PRECAUTIONS IN THE USE OF IONIZING RADIATIONS IN INDUSTRY

THE Factory Department of the Ministry of Labour and National Service has produced an important and interesting booklet which gives a clear warning to the industrial worker using X-rays or the radiations from radioactive substances of the potential hazards and dangers to which he is exposed and of the precautions he needs to take to protect himself*. At the same time it illustrates the wide and rapid spread of the use of these radiations in industry for the examination, testing and improvement of products and processes. In the introduction to the booklet the numerous applications are outlined. These cover X-ray radiography of metals; X-ray fluoroscopic examination of manufactured articles; X-ray diffraction analysis of crystalline compounds; gamma radiography; elimination of static electricity; thickness control and measurement; and radioactive tracer methods to elucidate the mechanism of chemical, physical, engineering and biological processes. It is stated that no industrial processes coming under the Factories Act have as yet been reported in which neutrons, protons and deuterons, which are biologically very dangerous radiations, have been used; but the possibility that these particles may soon find suitable applications, particularly neutrons for radiography and diffraction, cannot be excluded.

It is emphasized in the section dealing with health hazards that experience so far shows that, with proper forethought and care, risks of impairment of the health of work-people in factories where ionizing radiations are used can be countered; but that complete immunity from harmful effects depends on an intelligent appreciation of the properties of the various radiations and of their potential damaging effects on the human body, and on vigilant attention being paid to the necessary precautions. This seemingly calls for specially and technically trained staff; in fact, to appreciate fully the detailed and valuable information given in the booklet the reader must have more than a nodding acquaintance with the terminology of radiation physics and chemistry.

In another section recommended maximum permissible dosage-rates, based mainly on the internationally agreed values adopted at the Sixth International Congress of Radiology 1950, are quoted and explained, and the latter half of the booklet is devoted to recommended precautions, both of a general nature and when using particular apparatus

or methods. Under the heading of general precautions, the following categories are dealt with: planning and equipment; inhalation and ingestion precautions; supervision, training and monitoring; flow or dosimeter tests of workers' radiation exposures; and medical supervision. Special precautions are discussed separately for X-radiography, X-ray fluoroscopy, X-ray crystallography, gamma radiography, radioactive static eliminators, thickness gauges, radioactive tracer work and the handling of unsealed radioactive materials. The booklet ends with a valuable comprehensive bibliography of published memoranda on radiological hazards and protection.

The Factory Department of the Ministry of Labour and National Service is to be congratulated on the production of such an informative and timely booklet; it is a work which boldly presents the dangers of the new and powerful methods but yet, by indicating to industrialists how adequate precautions can be taken to safeguard their workers, wisely advocates the introduction and expansion of the use of ionizing radiations in industry.

ISOLATION AND PROPERTIES OF ALPHA-CORTICOTROPIN* FROM SHEEP PITUITARY GLANDS

By PROF. CHOH HAO LI, IRVING I. GESCHWIND, ANTHONY L. LEVY, J. IEUAN HARRIS, JONATHAN S. DIXON, NING G. PON and JERKER O. PORATH

Hormone Research Laboratory, Department of Biochemistry, University of California, Berkeley

IN an earlier communication¹ we described the preparation of a highly purified ACTH fraction (*E*) from an acid acetone extract of sheep pituitaries. We wish to report herewith the isolation from fraction *E*, without pepsin digestion, of a peptide (α -corticotropin) which behaves as a pure substance. This hormone is clinically active, and possesses adrenal-stimulating activity according to the results of standard bioassay procedures for adrenocortical function. While this work was in progress, the isolation and properties of corticotropins *B* and *A* from pig glands was reported by investigators from the Merck² and the Armour³ laboratories, respectively.

The first step in a typical isolation of α -corticotropin is the precipitation at pH 9.3-9.4 of inactive material from a solution of fraction *E* in 50 per cent dioxane. The supernatant obtained from this step is further purified by zone electrophoresis on starch⁴. An electrophoretic pattern obtained in this manner is illustrated in Fig. 1. The active fraction is eluted from segments 6-7 and then chromatographed on 'Amberlite XE-97' resin under the conditions shown in Fig. 2. The contents of tubes 34-49 are combined, desalted, and submitted to 100 transfers in the all-glass counter-current distribution apparatus of Craig and Post⁵ using a 2-butanol/0.5 per cent trichloro-

* In accordance with the suggestion of the Merck² and Armour³ groups in designating pepsin-hydrolysed pig ACTH as corticotropin *B*, and the unhydrolysed hormone as corticotropin *A*, we have chosen to designate unhydrolysed ACTH obtained from sheep pituitaries as α -corticotropin, since many of its chemical and physicochemical characteristics differ from those described for corticotropin *A*.

* Ministry of Labour and National Service: Factory Department. Factory Form 234: Precautions in the Use of Ionizing Radiations in Industry. Pp. 11+18. (London: H.M.S.O., 1953.) 2s. net.

acetic acid system (Fig. 3). The material in those tubes falling within the theoretical distribution curve for a partition coefficient of 3.20 is again desalted, and re-distributed (fifty transfers) in a 2-butanol/0.1 per cent trichloroacetic acid system (Fig. 4). Tubes 10-21, the contents of which follow the theoretical distribution curve for a partition coefficient of 0.41, yield α -corticotropin, which behaves as a single substance as judged by the following additional criteria of purity.

(a) *Zone electrophoresis*. Zone electrophoresis on starch at pH 7.0, 8.2, 9.1, 10.2 and 11.2 shows that α -corticotropin migrates as a single zone which contains the ACTH activity. (b) *Chromatography*. Elution analysis of α -corticotropin on 'XE-97' resin with 0.08 M sodium bicarbonate gives a single peak. (c) *Carboxyl end-group analysis*. When α -corticotropin is treated with carboxypeptidase, a single C-terminal amino-acid, phenylalanine, is released. Kinetic experiments show further that phenylalanine, glutamic acid and leucine are released successively in amounts approaching equimolar proportions. These results suggest that α -corticotropin is composed of a single peptide chain, terminating in the sequence ... leu.glu.phe. (d) *Chemical composition*. Amino-acid analyses of different preparations of α -corticotropin are consistent with the view that the product is a single chemical species. (e) *Biological assay*. Assay of the hormone in hypophysectomized rats

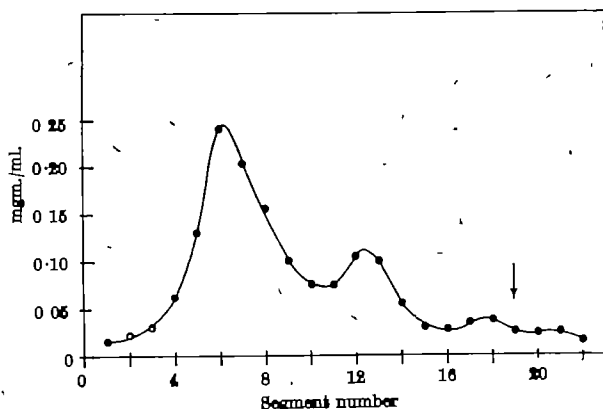


Fig. 1. Zone electrophoresis on starch of the dioxane supernatant of fraction B; 40-cm. trough, 1 cm. per segment. pH 11.1 (0.1 M Na_2CO_3), 200 volts, 16 hr.

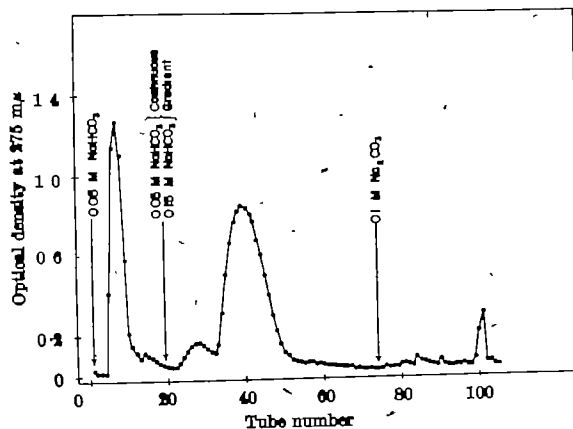


Fig. 2. Chromatography on 'XE-97' resin (Na form) of material obtained from zone electrophoresis; 10 ml. per tube. The hormonal activity is located in tubes 34-49

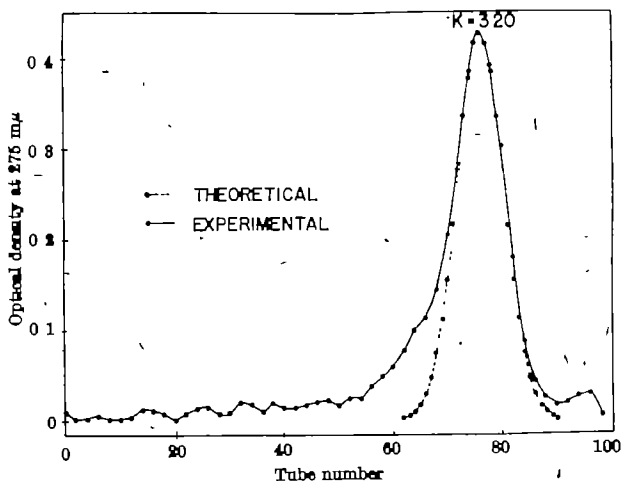


Fig. 3. Counter-current distribution (100 transfers) of material obtained from chromatography on 'XE-97' resin. System: 2-butanol/0.5 per cent aqueous trichloroacetic acid

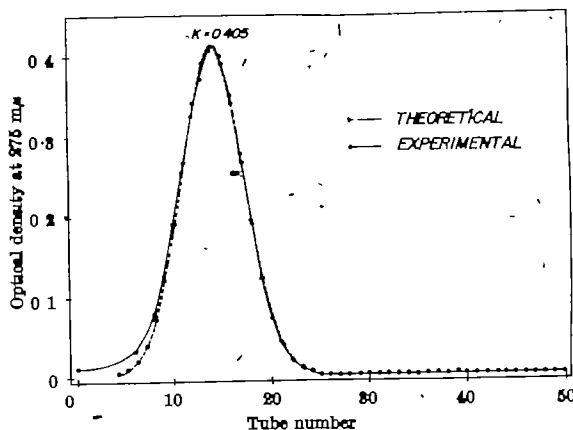


Fig. 4. Counter-current distribution (50 transfers) of α -corticotropin. System: 2-butanol/0.1 per cent aqueous trichloroacetic acid

reveals no evidence of contamination with either thyrotropin, somatotropin or gonadotropin; the local test in pigeons shows the absence of prolactin activity. Bioassay for melanophore-expanding activity in hypophysectomized *Rana pipiens* indicates that α -corticotropin possesses an intermediate contamination of less than 0.1 per cent. The adrenal-stimulating activity as estimated by the adrenal ascorbic acid depletion method⁶ is approximately 150 I.U. per mgm. In hypophysectomized rats, injection of the preparation in beeswax-peanut oil suspension⁷ causes hypertrophy of the adrenal cortex, as judged by histological changes and by adrenal weight increment.

The molar ratio of amino-acids in α -corticotropin is as follows: alanine 3, arginine 3, aspartic acid 2, glutamic acid 5, glycine 3, histidine 1, leucine 1, lysine 4, methionine 1, phenylalanine 3, proline 4, serine 3, tryptophan 1, tyrosine 2 and valine 3. Tyrosine and tryptophan were estimated spectrophotometrically⁸, while the other amino-acids, including tyrosine, were estimated by quantitative paper chromatography of their dinitrophenyl derivatives⁹. The minimum molecular weight of α -corticotropin, computed from these analytical data, is approximately 4,500. A similar value may also be

calculated for the equivalent weight if it is assumed that one mole of phenylalanine is released per mole of peptide by the action of carboxypeptidase. The isoelectric point of α -corticotropin, estimated from zone electrophoresis on starch, is found to be pH 7.0.

It is of interest to note that certain properties of α -corticotropin are different from those reported for corticotropins A and B. For example, all three preparations differ markedly in amino-acid content^{10,11}; furthermore, the partition coefficient of corticotropin A in a 2-butanol/0.2 per cent trichloroacetic acid system is 1.82¹², whereas that of α -corticotropin in the same system is 0.75. On the other hand, the C-terminal tripeptide sequence in α -corticotropin is identical with that reported for corticotropin A¹⁰, and both preparations possess comparable ascorbic acid depleting potencies.

This investigation was aided in part by grants from the U.S. Public Health Service and Eli Lilly and Company. We also wish to acknowledge the generous support of Merck and Co. and the Armour Laboratories during the early stages of this investigation. [Nov. 27.]

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EFFECTS OF ALPHA-(1-NAPHTHYLMETHYLSULPHIDE)-PROPIONIC ACID ON THE GROWTH OF EXCISED TOMATO ROOTS

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EARLIER work¹ has shown that the main axis meristems of excised tomato roots function only for a limited time when the roots are grown in constantly renewed modified² White's medium. This medium is of favourable pH, contains an adequate concentration of all the necessary nutrients and will promote over a prolonged period a high rate of increase in fresh root weight. The main axis, however, ceases to increase in length while the lateral roots are still growing rapidly. Further increase in fresh weight is then due to the growth of first-order laterals; at a later stage it is dependent upon the activity of second- and third-order lateral meristems. The duration of meristematic activity in individual root tips can be prolonged by repeatedly excising

them from the root systems to which they have given rise³. This survival of activity in meristems excised at regular intervals can be further prolonged by low-intensity illumination of the cultures⁴. It is decreased by increasing the sucrose concentration in the medium⁵ or by additions of β -indolylacetic acid (IAA) even at non-inhibitory concentrations⁶.

On this and other evidence the hypothesis has been advanced⁷ that the level of meristematic activity in roots is controlled by a hormone which at low concentration stimulates and at high concentration inhibits growth. Irreversible loss of meristematic activity is considered to result when the concentration of this hormone reaches a critical supra-optimal level. This hormone, or some precursor of it, is considered to be synthesized in the older parts of the root and transported to the main apex. It is postulated that a sub-optimal concentration of this hormone in the newly initiated meristem continuously increases as, during culture, the root system derived from the meristem increases in size.

The above hypothesis was supported by the findings that the response of root meristems to α -(1-naphthylmethylsulphide)-propionic acid (NMSP)⁸ changed during culture and that survival of meristems, subcultured in medium of high sucrose content, was enhanced by NMSP-treatment⁹. This substance, which conforms to McRae and Bonner's¹⁰ criteria for anti-auxins, was shown by Åberg¹¹ to antagonize the inhibition of seedling root growth by 1-naphthaleneacetic acid, by 2:4 dichlorophenoxyacetic acid and to a lesser extent by β -indolylacetic acid.

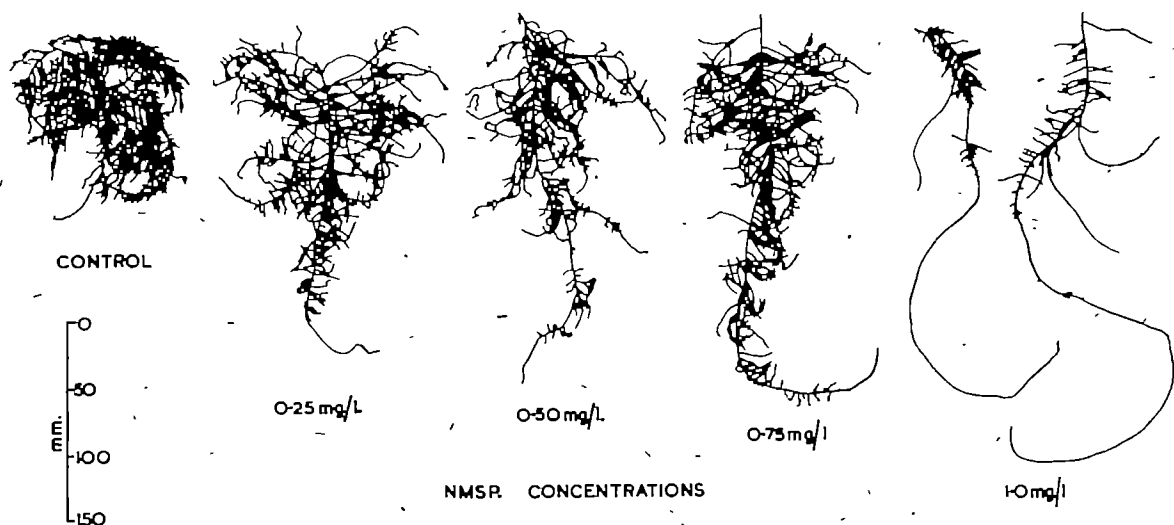
A study has now been made of the effects of NMSP on the growth of excised tomato roots (clone of Sutton's Best-of-All) in large volumes of medium (1,000 ml. per root). Modified White's medium in which iron (1.4 p.p.m.) was supplied as ferric citrate instead of as sulphate was used. Each flask was inoculated with a single 10-mm. root tip and incubated at 27° C. On the ninth day of culture a filter-sterilized, concentrated solution of NMSP was used for establishing in the medium concentrations ranging from 0.25 to 1.0 mgm./l. Roots were harvested after thirty-one days, by which time all roots, with the exception of some of those receiving 1.0 mgm./l. NMSP, had ceased main axis growth. Mean values for main axis lengths are shown in the accompanying table. The characteristic morphology of the control and NMSP-treated roots is illustrated by the accompanying photographs of representative roots.

At all NMSP concentrations the duration of main axis growth was prolonged beyond that of the controls. At 0.25 and 0.50 mgm./l., linear growth-rate of the main axis was initially increased, at higher concentrations decreased. During the first few days after its addition, 1.0 mgm./l. was clearly inhibitory

MAIN AXIS GROWTH OF EXCISED TOMATO ROOTS DURING 31 DAYS OF CULTURE

No. of cultures	Mgm./l. NMSP added on the ninth day of culture	Mean values for increase in main axis length (mm.) $\pm$ standard errors
10	Nil	171 $\pm$ 10
7	0.25	275 $\pm$ 15
6	0.50	305 $\pm$ 12
6	0.75	372 $\pm$ 26
8*	1.0	422 $\pm$ 28

* Three roots the main axis length of which did not exceed the mean value for controls were omitted in calculating mean and standard error.



Photographs of representative control and NMSP-treated roots

and in some cases the main axis meristems did not survive this period. Excluding these roots (see footnote to the table) it was found that increase in NMSP concentration up to 1.0 mgm./l. caused a progressive increase in the average values for total main axis growth. At 0.50 and particularly at 0.25 mgm./l., growth of first-order lateral meristems was not inhibited and the duration of their growth was prolonged. This enhancement of lateral growth was most marked where only a limited extension of main axis growth occurred. At the higher NMSP concentrations, particularly at 1.0 mgm./l., lateral growth was checked. Youngest laterals were inhibited most strongly.

The effect of NMSP described above can be interpreted on the basis that it acts by antagonizing a natural hormone present in the root meristems. The higher concentrations are considered to induce a sub-optimal effective hormone-level in the meristems, thereby lowering the growth-rate but most effectively prolonging the duration of activity of individual meristems. The lower concentrations are considered to reduce the supra-optimal hormone concentration, developed during the first nine days of culture, to one nearer, but still probably above, the optimum. They therefore increase growth-rate but are less effective in prolonging the duration of meristematic activity. Lateral meristems, having a lower hormone content than the main axis meristems, are almost completely inhibited by NMSP concentrations which permit main axis growth. Cessation of main axis growth in the control roots and in roots treated with the lower concentrations is considered to result from the development, as growth proceeds, of a critical supra-optimal hormone concentration; inhibition of lateral growth in high NMSP concentration is regarded as due to a lowering of the effective hormone concentration in the lateral meristem to a critical sub-optimal level.

Elsewhere⁴ it has been shown that β -indolylacetonitrile (IAN), at concentrations causing up to 50 per cent inhibition of main axis growth, does not markedly affect the duration of activity of meristems repeatedly subcultured. Evidence has also been obtained that the effects of NMSP on meristematic activity cannot be explained in terms of an NMSP-IAA antagonism⁴. The view is therefore advanced

that a natural hormone, other than β -indolylacetic acid or β -indolylacetonitrile, controls the activity of excised tomato root meristems grown under our conditions of culture. This emphasizes the interest which will be attached to studies involving the other growth regulators the presence of which in roots has been revealed by recent chromatographic work⁴.

[Dec. 15.

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A LARGE HIGH-PRESSURE ULTRAFILTER

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ULTRAFILTRATION is a useful technique for concentrating weak solutions of proteins. The process is essentially simple and should avoid the partial loss of material frequently incurred by the use of chemical methods. Unfortunately, the rate of concentration is often too slow to be of much value, especially with labile material.

An ultrafilter has been designed for the rapid concentration of bacterial toxins and might be found useful in other fields where highly concentrated solutions of proteins are required. The apparatus has a total capacity of 15 litres and a filter area of 400 sq. cm. Ultrafiltration through a collodion membrane is carried out under nitrogen at a pressure of 300 lb. per sq. inch. The membrane is supported on a flat smooth porous tile, which in turn rests on a perforated steel plate. The ultrafiltrate is collected in a flask beneath the filter.

Construction. The filter consists of a cylinder of $\frac{1}{2}$ -in. mild steel, 12 in. high, 9 $\frac{1}{4}$ in. internal diameter. Two flanges, one at the top, one at the bottom, each 1 $\frac{1}{2}$ in. wide, are tapped to receive sixteen $\frac{1}{4}$ -in. bolts

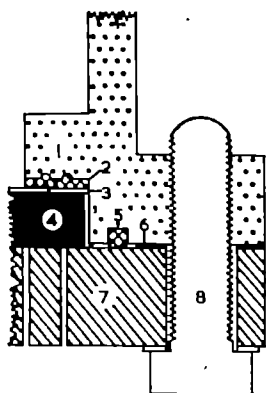


Fig. 1. 1, Flange. 2, Rubber washer. 3, Collodion membrane. 4, Porous tile. 5, Rubber ring. 6, Metal washer. 7, Perforated base plate. 8, Bolt.

which secure the lid and base plate. The lid of $\frac{1}{4}$ -in. steel is drilled to accommodate a pressure gauge, a safety valve, a release valve and an inlet valve bearing a union for the nitrogen pipe. Between the lid and the rim, which are both grooved, an $\frac{1}{4}$ -in. rubber washer is fitted.

The construction of the bottom of the apparatus is shown in Fig. 1. The base plate (7) of $\frac{1}{4}$ -in. steel is drilled with nine concentric rings of holes 0.1 in. in diameter and half an inch apart. The porous tile (4) of white unglazed porcelain, ground flat on both sides, is approximately $\frac{1}{8}$ in. thick. Tightening the bottom bolts presses the edge of the membrane (3) between the tile (4) and a rubber washer $\frac{1}{4}$ in. thick (2) resting on a grooved flange (1); this provides a leak-proof seal. The rubber washer is compressed to about half its thickness; this allows some latitude in the thickness of the tile. Excessive pressure on the tile is prevented by the metal washer (6). The bolts were screwed up as tightly as possible. A hard rubber ring (5) which projects from a rectangular groove prevents any leakage of ultrafiltrate. The whole apparatus is tin-plated to prevent corrosion.

Preparation of the Membrane. A sheet of 'Cellophane' (British Cellophane, Ltd., P.T. 300) is stretched over a square of plate glass and fixed to the under-side with 'Cellotape'. The glass sheet is placed on a tray, 'Cellophane' surface uppermost, and an 8 per cent solution of collodion in glacial acetic acid (I.C.I.) is poured on to it. When the surface has been covered the glass is picked up with the aid of rubber gloves and drained from each corner in turn until most of the surplus collodion has been removed. It is then plunged into cold water. After a few minutes the 'Cellophane' sheet can be cut away from the edge of the glass. The collodion membrane can then be separated easily from the 'Cellophane' sheet. It is allowed to harden in running water over-night. After hardening, the membrane is found to have one smooth surface and the other slightly uneven, and it is placed on the tile smooth side upwards and trimmed to fit. Two litres of 0.5 per cent solution of sodium bicarbonate are then forced through the membrane under a pressure of 100 lb. per sq. in. to remove any traces of acid.

Six membranes prepared in succession by this method have all proved to be satisfactory.

Performance. Under a pressure of 300 lb. per sq. in., the bicarbonate solution passed through the membrane at the rate of approximately 10 litres an

hour. At the same pressure, 2 litres of a solution of horse haemoglobin in distilled water (40 mgm. per 100 ml.) were reduced practically to dryness in $2\frac{1}{2}$ hr. The haemoglobin remained on the surface of the membrane as a thick film, too dry to flow. 3 ml. of the ultrafiltrate gave no reaction to the benzidine test. 3 ml. of a 1/5,000 dilution of the original haemoglobin solution gave a positive reaction. This showed that less than 1/5,000 part of the haemoglobin had passed through the membrane.

In five successive tests no haemoglobin was detected in the ultrafiltrate. On three of these occasions a hand spectroscope was used, on two the benzidine test. On another occasion 1,200 ml. of papain digest broth containing *Olostridium welchii* epsilon toxin was reduced in $2\frac{1}{2}$ hr. to approximately 10 ml. of fluid which had the consistency of treacle. The ultrafiltrate was non-toxic; but the 'treacle' was intensely toxic.

To maintain rapid rates of filtration it was necessary to rock the apparatus gently to and fro every 15 min. to avoid premature accumulation of highly concentrated material on the surface of the membrane. This could probably be avoided by the incorporation of some form of stirrer.

The pressure fell during filtration by about 10 lb. every 30 min. This was of little importance with small volumes. For prolonged filtration it is hoped to fit an automatic release valve to keep the pressure constant at 300 lb. per sq. in.

The apparatus was made by Messrs. D. Mackay, Cambridge, and the tiles by Messrs. James Macintyre and Co., Ltd., Burslem. We owe thanks to many for useful suggestions, especially Mr. J. Welch, of Messrs. D. Mackay, and Mr. H. Proom, of the Wellcome Research Laboratories. [Oct. 21.]

CRYSTALLINE SWELLING OF MONTMORILLONITE

Use of Electrolytes to control Swelling

HOFMANN, ENDELL AND WILM¹ first demonstrated that montmorillonite had a layer structure similar to mica but differed from it in that the interlayer distance was variable and dependent on water content. Many workers²⁻⁴ have since verified this one-dimensional crystalline swelling and have shown that the exchangeable cations, situated between the silicate sheets, are largely responsible for swelling. Initially, swelling is a result of hydration of the cations⁵; but later it proceeds in 3-A. steps⁶. All the above workers are in agreement that with calcium-montmorillonite the interlayer swelling does not proceed beyond 20 Å., but Mering⁷ and Barshad⁸ failed to confirm the report of Hofmann *et al.*¹ that sodium-montmorillonite gave a spacing very much greater than 30 Å. in water. This record is probably to be interpreted as failure to observe a definite diffraction line up to the low-angle cut-off of the camera. Mering concluded that crystalline swelling ceased at 20 Å., when the (001) spacing became very diffuse.

In contrast to its observed crystalline swelling, sodium-montmorillonite will swell to twenty times its own volume in water⁹. Also in contrast to the limited crystalline swelling are the physico-chemical measurements on sodium-montmorillonite^{9,10}, which suggest that in suspensions and gels the particles are the fundamental silicate sheets, 10 Å. thick.

During work by one of us (J. P. Q.), with Dr. R. K. Schofield, on the permeability of clays to electrolytes, it became desirable to know the (001) spacing of montmorillonite in sodium chloride and calcium chloride solutions of various concentrations. X-ray diffraction measurements made on montmorillonite while immersed in these solutions are given in the accompanying table.

(001) SPACING OF SODIUM-MONTMORILLONITE IMMERSED IN SODIUM CHLORIDE

NaCl normality	$d_{(001)}$ (in Å.)
4	15.4
1	18.7
0.5	19.0
0.01	40

(001) SPACING OF CALCIUM-MONTMORILLONITE IMMERSED IN CALCIUM CHLORIDE

CaCl ₂ normality	$d_{(001)}$ (in Å.)
8	15.8
2	18.7
0.2	19.0
water	19.0

The observation of a definite spacing at 40 Å. is of interest as it indicates that crystalline swelling can proceed beyond 20 Å. The results also show that electrolytes can be used as a convenient means of controlling swelling in the range of high water content.

Mering⁷ has shown that almost all the macroscopic swelling of montmorillonite takes place at water contents equivalent to a relative humidity of greater than 99 per cent. To control the water content and measure the X-ray spacing in this range by direct methods would involve very precise temperature control.

This work was carried out at Rothamsted Experimental Station, Harpenden, Herts, during the tenure, by both authors, of C.S.I.R.O. (Australia) studentships.

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Manner of Swelling of Montmorillonite

THE use of electrolytes as a means of controlling the swelling of montmorillonite was so convenient that a study was made of the variation of (001) spacing with electrolyte concentration for montmorillonite saturated with the following cations: $H^+(H_2O^+)$, Li^+ , Na^+ , K^+ , NH_4^+ , Ca^{++} , Mg^{++} , Cu^{++} , Ba^{++} , $Cu(NH_3)_4^{++}$, Al^{3+} .

An oriented flake¹ of sodium-montmorillonite (Wyoming bentonite) about 0.03 mm. thick was placed in a plastic tube of 0.3 mm. internal diameter. The flake was saturated with the desired cation by passing a strong (1–4 *N*) salt solution through the plastic tube. Then a solution of the same salt at the required concentration was passed through the tube

and finally the ends of the tube were sealed, keeping the flake immersed in the salt solution. Except where otherwise stated, the salts used were chlorides.

A diffraction pattern of the oriented flake, immersed in the salt solution, was obtained by using a curved crystal monochromator which had been modified so that spacings up to 400 Å. could be recorded on a flat film placed at the focus. Copper $K\alpha$ radiation was used.

For (001) spacings up to 22 Å., the (001) diffraction lines were relatively sharp and formed a rational or irrational series. For (001) spacings of greater than 30 Å., the (001) diffraction lines became diffuse with only one or two orders visible to the eye. Although the (001) line could easily be measured visually, these diffraction patterns were microphotometered and interpreted using a one-dimensional Fourier transform method².

According to their effect on the swelling of montmorillonite the cations may be grouped as follows.

H^+ , Li^+ : in 4 *N* solutions, the (001) spacing was 15.4 Å. With decreasing concentrations, the (001) spacing increased, giving a rational series of (001) lines at 19 Å. and 22.5 Å., indicating that the expansion was stepwise. At 0.5 *N* the spacing jumped from 22.5 Å. to 36 Å. and the diffraction pattern became diffuse. The interlayer spacing then increased continuously, being linear with respect to $1/\sqrt{N}$, so that at 0.01 *N* the spacing was about 140 Å. The diffuse nature of the diffraction pattern prevented observations beyond this point with the equipment available.

Experiments with acid-montmorillonite had to be completed within several hours of bringing the montmorillonite into contact with hydrochloric acid, as after this time the spacing changed. In concentrations of less than 0.5 *N* hydrochloric acid the spacing collapsed to 22.5 Å. within a day. This change is almost certainly due to acid attack on the clay releasing Al^{3+} ions³, and it is consistent with the anomalous swelling properties of acid-montmorillonite⁴.

Na^+ : In sodium chloride the montmorillonite departed from the above behaviour in that stepwise swelling proceeded only to 19 Å. and then, at 0.3 *N*, the spacing jumped to 40 Å. In more dilute solutions it followed the same line as H^+ and Li^+ . The variation of the interplanar spacing with $1/\sqrt{N}$ for sodium chloride solutions is shown in Fig. 1.

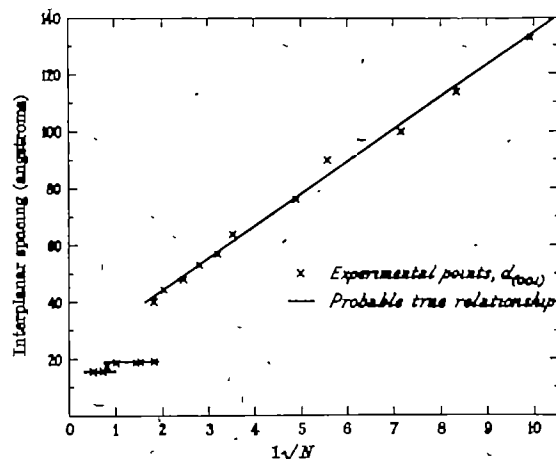


Fig. 1. Lattice expansion of sodium-montmorillonite in sodium chloride solutions

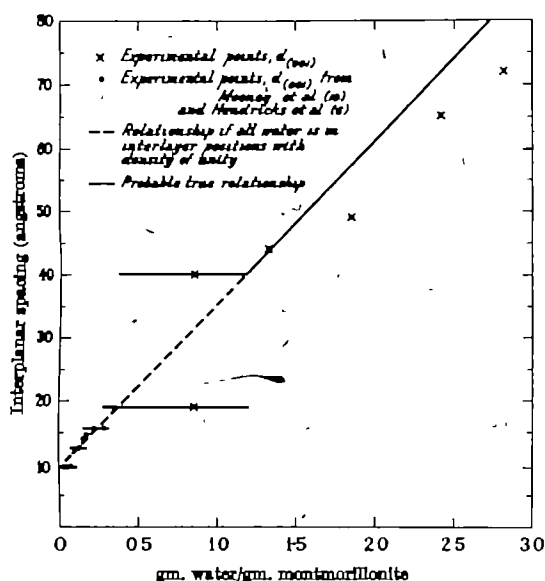


Fig. 2. Lattice expansion of sodium-montmorillonite as a function of water content

In sodium sulphate solutions swelling proceeded in the same manner, the spacings being the same as those of more dilute sodium chloride solutions.

Experiments with hectorite, from Hector, California, U.S.A., and montmorillonite, from Redhill, England, indicated that in sodium chloride solutions their behaviour was similar to that of Wyoming montmorillonite.

K^+ , NH_4^+ , Ca^{++} : The spacing of montmorillonite saturated with these cations normally did not proceed beyond 15 Å., even in water. However, by expanding the montmorillonite in sodium chloride and then replacing the sodium ions by potassium ions, using weak potassium chloride solutions, large spacings were obtained with potassium-montmorillonite. Ammonium-montmorillonite behaved in the same way.

Mg^{++} , Ca^{++} , Be^{++} , Al^{++} : With these ions the spacing increased from 15 Å. to a maximum of 19 Å. with decreasing concentration.

$Cu(NH_3)_4^{++}$: Montmorillonite saturated with this ion gave a spacing of 12.4 Å. which was independent of electrolyte concentration.

Fig. 2 shows the results obtained by adding known amounts of water to sodium-montmorillonite. It is evident that, within experimental error, which is largely due to the difficulty of maintaining equilibrium at such high relative humidities, most of the swelling of montmorillonite can be accounted for by lattice swelling. Between water contents of 0.37 and 1.19 gm./gm. clay, both 19-Å. and 40-Å. spacings are present, the former decreasing in number and the latter increasing with increasing water content. The 40 Å. spacing gives a diffuse second-order diffraction line at 20 Å., so that while the water content increases by three times the 19-Å. line shifts very little in position but becomes diffuse. It was this behaviour that led Mering⁵ to conclude that the interlayer distance did not increase beyond 20 Å.

The above results suggest that the swelling of montmorillonite takes place in two rather distinct ways. First, below 22 Å. the interlayer expansion is stepwise⁶ and very dependent on the exchangeable cation⁷. For the monovalent cations the number of

water layers taken up is directly related to the hydration energy of the cation. Secondly, after the jump to greater than 35 Å., where it occurs, the expansion is continuous and independent of cation for monovalent cations. In this region the montmorillonite is probably developing a diffuse double layer and behaving as a colloid⁸. The swelling is then essentially osmotic and is expected to be independent of cation for ions of the same valence.

The sudden jump in spacing from about 20 Å. to about 40 Å. is interesting and is probably associated with reversal of the force due to the charge on the montmorillonite sheets. At low spacings the force will be electrostatic and attractive, as in mica, whereas at high spacings the charge will result in a repulsive (osmotic) force⁹.

At high spacings this repulsive force is presumably balanced by van der Waals-London attractive forces⁷.

For the swelling to pass from the first to the second region the hydration energy of the monovalent interlayer cations must be sufficient to expand the spacing to about 20 Å., that is, to overcome the electrostatic attraction. The hydration energy of the large monovalent cations is insufficient to overcome this potential barrier, so that when collapsed, montmorillonite saturated with these cations cannot expand beyond about 15 Å. However, if this barrier is overcome by some other means, then the montmorillonite can continue to expand. This behaviour is consistent with the observation of Mattson¹⁰, who noted that Sharkey soil colloid, a montmorillonite, swelled greatly when saturated with potassium ions but not after drying.

Why the divalent ions with their greater hydration energy do not cause greater expansion is not clear. However, several factors will contribute to limit their swelling. Because divalent ions have a much larger sphere of dielectric saturation, the electrostatic attractive forces between neighbouring montmorillonite sheets will not diminish as rapidly as they do for monovalent ions. In addition, the theory of Langmuir¹¹ indicates that the osmotic repulsive force will be much less for divalent ions, and montmorillonite sheets separated by large distances (greater than 25 Å.) will collapse together if this force is insufficient to counterbalance the van der Waals attractive forces.

A full account of this work will be published elsewhere. It was carried out at Rothamsted Experimental Station, Harpenden, Herts, during the tenure of a C.S.I.R.O. (Australia) studentship.

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Adelaide.
Aug. 28.

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² MacBryan, D. M. O., and Norrish, K. (to be published).

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⁹ Mattson, B., *Soil. Sci.*, **38**, 177 (1935).

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LETTERS TO THE EDITORS

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Temperature Distribution within the Earth's Core

IN view of the recent article by Prof. F. E. Simon in *Nature* on the melting of iron at high pressures¹, it seems desirable to review the hypothesis I put forward to account for a solid inner core within the earth².

At the boundary between the silicate mantle and the iron core there must be a discontinuity in the melting-point-depth curve, although the actual temperature must be continuous across the boundary. The form of this discontinuity could, mathematically, take any of the three cases shown in Fig. 1. Case (i), in which the melting-point curve in the core is always above that in the mantle, is impossible; for the actual temperature curve must lie below the melting-point curve in the mantle, above the melting-point curve in the core, and yet be continuous across the boundary. Cases (ii) and (iii) are both possible. In case (ii), the melting-point curve in the core never rises above the value of the melting point in the mantle at the core boundary, and in case (iii) it exceeds this value for part of the core. If case (ii) is the truth, then as the earth cooled from a molten state, the entire core would be left liquid, whereas if case (iii) is the truth, then I have shown that a solid inner core would be formed². As the earth cooled still more, the mantle would begin to solidify from the inside outwards, trapping a liquid layer between it and the now solid inner core. The above arguments can be modified if the earth were formed by the cold accretion of dust particles and afterwards heated up. If the earth became completely molten, its subsequent history would be the same as that already discussed. On the other hand, if the earth is still heating up, then either case (ii) or case (iii) could lead to a liquid core with a solid inner core.

However, most advocates of a cold origin for the earth consider the earth as relatively homogeneous at the beginning and to have differentiated as it heated up (see, for example, Urey³). The energy produced in the formation of the iron core, approximately 2×10^{28} ergs, would be released as heat near the core and would thus keep temperatures so high that a solid core would be impossible unless the earth had become entirely molten and all differentiation taken place, its subsequent history being the same as that of an earth with a hot origin. Finally, Rosenblatt⁴ has considered the effect of a probable primeval endowment of uranium-236 and shown

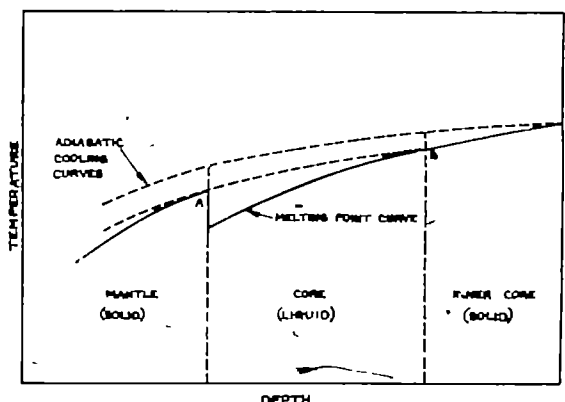


Fig. 2

that, owing to the relatively enormous disintegration-rate of this element, even a cold earth would have become completely molten. For these reasons, therefore, the rest of this communication is confined to the case of an earth cooling from a molten state.

Cases (ii) and (iii) can now be examined in the light of the work of Prof. Simon¹. There are few data available on the melting point of silicates at the high pressures that prevail near the core boundary. The recent work of Uffen⁵ based on seismic data and the theory of the solid state indicates that the melting point in the mantle at 2,900 km. is about 5,000° K. Unless there has been considerable cooling of the mantle, this would favour case (ii), that is, an all-liquid core, since the melting point of iron even at the centre of the earth is less than 4,100° K.¹ However, such a large difference in the two melting points seems unlikely. The earlier work of Daly⁶ gives a melting-point temperature of about 4,000° for the mantle at 2,900 km., which indicates that case (iii), that is, a solid inner core, is possible. Indeed, if this is the truth, as seems most likely from seismic evidence, it is possible to calculate the actual temperature at the core boundary by using the adiabatic temperature gradient curve for the core as obtained by me².

Since the boundary *B* of the inner core is the point of transition between the liquid and solid state in the core, the melting point at *B* must be the actual temperature at that level. Hence, by extending the adiabatic curve back from this point to *A*, the boundary between the core and mantle, we can obtain the actual temperature at *A* (see Fig. 2). The actual temperature at *A* must be less than the melting point of the silicates that compose the mantle and above the melting point of iron. Taking Prof. Simon's¹ value of the melting temperature at *B* as 3,900° K., the actual temperature at *A* is 3,800° K.

Finally, it is possible to obtain an upper limit for the melting point of the mantle at the core boundary by calculating the adiabatic curve that passes through *C*, the melting point at the centre of the earth. The melting-point curve of the mantle must be below this curve, or a solid inner core could not have formed. Prof. Simon's value for the melting point at *C* is 4,040° K., and this leads to the upper limit to the melting point of the mantle at 2,900 km. as 3,880° K. Prof. Simon places an upper limit of 4,880° K. for his temperature at *C*, and this in turn would raise

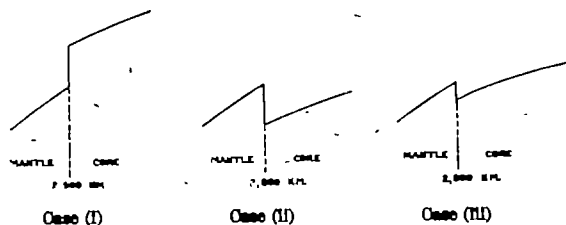


Fig. 1. Possible forms of the melting-point-depth curve in the neighbourhood of the core boundary

the upper limit to the melting point of the mantle at the core boundary to 4,000° K.

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- ¹ Simon, F. B., *Nature*, 172, 745 (1953).
² Jacobs, J. A., *Nature*, 172, 297 (1953).
³ Urey, H. C., "The Planets" (Yale Univ. Press, 1952).
⁴ Rosenblatt, D. B., *Phys. Rev.*, 81, 1474 (1953).
⁵ Uffen, R. J., *Trans. Amer. Geophys. Union*, 33, 893 (1952).
⁶ Daly, R. A., *Bull. Geol. Soc. Amer.*, 54, 401 (1943); 57, 707 (1946).
⁷ Jacobs, J. A., *Can. J. Phys.*, 31, 370 (1953).

RECENTLY, Simon¹ has presented a method of estimating the melting-point temperature of iron at high pressure. This is of considerable geophysical interest as it is frequently argued that the earth's core is composed of iron². A method of estimating the melting-point temperature in the mantle had been proposed previously by Uffen³; but no reliable method of estimating this value in the core was then available. These two results are combined in Fig. 1, the dotted lines indicating our estimated limits of error. This curve is very similar to that given by Jacobs⁴ in his qualitative explanation for the existence of a solid inner core to the earth. Furthermore, it provides an upper limit of 5,000° K. and a lower limit of 3,000° K. for the temperature at the core-mantle boundary. These two observations provide a basis for discussing the plausibility of some of the theories of the constitution and history of the earth's interior.

In Jacobs's explanation of the solid inner core, it is necessary to postulate a discontinuous decrease in the melting point at the mantle-core boundary. The quantitative results appear to support this hypothesis; but the melting point at the centre of the earth is considerably lower than at the bottom of the mantle. According to these data, solidification from a molten state would commence at the core boundary and progress outward. A much greater amount of cooling through the mantle than hitherto expected by the proponents of the cooling-earth hypothesis would be required before the adiabatic temperature curve for the core could meet the melting-point curve for the core. If it is assumed that this cooling has occurred, then solidification would have recommenced

at the centre and progressed outward provided the melting-point gradient exceeded the adiabatic gradient. Jeffreys⁵ has shown that cooling by conduction alone could scarcely have progressed below the melting point in the mantle to depths greater than about 700 km. at the present age of the earth. It seems imperative, then, if the curves given above are reasonably close to the truth, to assume that cooling has been by slow convection currents in the 'solid' mantle. The alternative is that the melting point of iron must be considerably revised upwards and/or the melting point at the bottom of the mantle must be revised downwards.

As Simon has pointed out, the actual temperature at the boundary of the solid inner core would be the melting point of iron at that depth, since in the liquid part the actual temperature would be above the melting point while in the solid part it would be below the melting point. We might expect, then, that we could estimate the actual temperature in the liquid part of the core by computing the adiabatic gradient for this region and progressing outward from the 'known' temperature at the inner-core boundary. Valló's⁶ recent work, based on seismic data and theory of the solid state, gives $T_{\text{core}}/T_{\text{mantle}} = 1.38$, which leads to a mean gradient of 0.51° K./per km. in the liquid core. This is greater than the mean melting-point gradient of 0.33° K. per km. for this region as given by Simon's data. It would mean that no inner core could form from a cooling earth and still leave a liquid outer core, nor could convection currents occur as required by the Bullard-Elsasser theory of the origin of the earth's magnetic field. Bullard⁷ has estimated the mean adiabatic gradient in the liquid core to be 1.1° K. per km.; but his estimate was based on an assumed mean temperature of 10,000° K. Since the adiabatic temperature gradient is proportional to the temperature, Bullard's value reduces to 0.39° K. per km. if 3,500° K. is used instead of 10,000° K. This is still a little high, but could probably be reduced further by a more careful evaluation than was necessary for Bullard's calculations. With the data available at present, it is possible that convection currents would occur in the core as long as it is molten, and that the actual temperature lies close to Simon's melting curve.

The occurrence of a solid inner core may possibly be explained on the hypothesis of a cold origin for the earth with subsequent heating due to radioactivity. According to this hypothesis, the initial gradient would be essentially adiabatic with a temperature of about 2,000° K. at the mantle-core boundary⁸. Radioactive generation of heat, presumably concentrated near the earth's surface, would raise the temperatures so that the upper part of the mantle would melt⁹; the rising temperature in the interior would eventually meet the melting curve at the core boundary and melting would progress inward leaving a solid inner core. One would expect, however, that the actual temperature gradient in the liquid core would then be very small, if not reversed, so that convection currents could not arise. Furthermore, the layered nature of the earth would have to exist before melting began. This layering is more easily explained if the earth has passed through a molten stage.

The one conclusion we may draw with a fair degree of certainty and which depends on no particular theory of the earth's thermal history is that the actual temperature at the core boundary must lie

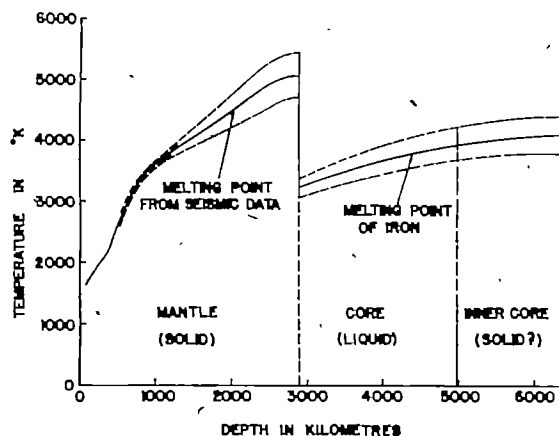


Fig. 1

between the upper limit given by the melting point at the bottom of the solid mantle, and the lower limit given by the melting point at the top of the liquid core, that is, between 5,000° K. and 3,000° K.

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¹ Simon, F. H., *Nature*, 172, 746 (1953).

² Bullen, K. H., "Introduction to the Theory of Seismology" (Camb. Univ. Press, 1947). Birch, F., *J. Geophys. Res.*, 57, 227 (1952).

³ Uffen, R. J., *Trans. Amer. Geophys. Union*, 33, 803 (1952).

⁴ Jacobs, J. A., *Nature*, 172, 297 (1953).

⁵ Jeffreys, H., "The Earth" (Camb. Univ. Press, 1952).

⁶ Vallé, P. H., *Annali di Geofisica*, 5, 41 (1953).

⁷ Bullard, R. O., *Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 6, 35 (1950).

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Fractionation of Isotopes by Distillation of some Organic Substances

In a recent communication having the above title, Baertschi, Kuhn and Kuhn¹ expressed surprise that substitution of carbon-13 for carbon-12 in the molecules CHCl_3 , CCl_4 , CH_3OH and C_2H_6 caused an enhancement of volatility, whereas substitution of chlorine-37 for chlorine-35 in the first two compounds, and of oxygen-18 for oxygen-16 in methanol, had the opposite effect. This led them to suggest that it might be a general rule for isotopic molecules containing a central atom that the molecular variety having the heavier isotope as central atom is more volatile than the isotopic molecule with the lighter central atom.

The purpose of this communication is to point out that these results can be understood on statistical thermodynamical grounds provided a plausible mechanism is assumed for intermolecular attraction in polyatomic molecules. It follows from the Saakur-Tetrode equation that the greater the mass of a molecule the greater is its translational entropy in the vapour, and therefore the greater is its probability of attaining the vapour state. (I wish to thank Prof. W. Kuhn and Dr. P. Baertschi for pointing out that the gas-mass-entropy effect will be compensated to some extent by the effect of mass on the entropy of the liquid.) A lucid explanation of this subtle connexion between volatility and molecular weight has been given by Sir Cyril Hinshelwood².

The entropy effect is, however, generally obscured by the over-riding influence of intermolecular attractions in the condensed phase, which normally increase with the size of the atom and with the number of atoms in the molecule. In consequence, greater molecular weight is usually associated with greater intermolecular attraction and lower volatility.

To explain the results of Kuhn *et al.*, it is necessary to postulate that intermolecular attraction is localized between nearest atoms of polyatomic molecules, and is not produced by the operation of central force fields between the molecules as units. In the case of carbon tetrachloride, it is clear that intermolecular attraction involving chlorine will predominate, since the carbon atoms are effectively screened. Thus isotopic replacement of carbon will mainly affect the entropy term, and the molecule containing the heavy isotope will be the more volatile. For isotopic replacement of chlorine, on the other hand, it appears

that the change in the entropy term is overruled by the change in the intermolecular attraction term and heavy chlorine lowers the volatility.

In the case of isotopically different polyatomic molecules, the relative vapour pressures P_H/P_L (where P_H and P_L are the vapour pressures of the heavy and light species respectively) can generally be expressed as a function of temperature as follows:

$$\log \frac{P_H}{P_L} = \Delta a - \frac{\Delta b}{RT}$$

Δa is usually positive because of the mass-entropy effect and favours the volatility of the heavier species. This tendency is opposed by Δb , which is positive and mainly reflects a difference ($\lambda_H - \lambda_L$) in the latent heat terms due to the heavier species having the smaller zero-point energy of quasi-oscillation in the liquid.

Assuming that the relative vapour pressures of isotopic carbon tetrachlorides conform to the above equation, and using $(\Delta a)_C$, $(\Delta b)_C$, $(\Delta a)_{Cl}$ and $(\Delta b)_{Cl}$ to represent the appropriate terms for carbon and chlorine exchange respectively, it follows from experimental data of Kuhn *et al.* that at 308° K. $(\Delta a)_C > (\Delta b)_C/RT$ and $(\Delta b)_{Cl}/RT > (\Delta a)_{Cl}$. Since chlorine exchange involves double the mass change of carbon exchange, it is probable that $(\Delta a)_{Cl} > (\Delta a)_C$ and $(\Delta b)_{Cl} > (\Delta b)_C$. Although this will lead to $(P_H/P_L)_C \neq (P_H/P_L)_{Cl}$, it should not appreciably alter the temperature $T = \Delta b/\Delta aR$ at which 'crossing-over' occurs. Below this temperature, the lighter species is more volatile, while above it the order of volatility is reversed. To explain the experimental results, it is further suggested that the ratio $(\Delta b)_{Cl}/(\Delta a)_{Cl}$ exceeds the ratio $(\Delta b)_C/(\Delta a)_C$ because of stereochemical factors which control the nature of intermolecular attraction.

This idea, which will be reported in full elsewhere, involves the assumption that the total intermolecular attraction per molecule in the liquid is the sum of the interactions involving pairs of atoms from neighbouring molecules, and that each type of atomic interaction (for example, $\text{C}\dots\text{C}$; $\text{C}\dots\text{Cl}$; $\text{Cl}\dots\text{Cl}$) has a separate zero-point energy of quasi-oscillation. On this basis, isotopic replacement involving the atomic interaction with the greatest zero-point energy will have the greatest influence on Δb . In general, the type of interaction having the greatest energy will also have the greatest zero-point energy, and in the above example will be $\text{Cl}\dots\text{Cl}$, followed in order by $\text{C}\dots\text{Cl}$ and $\text{C}\dots\text{C}$. Hence isotopic change of chlorine has a greater effect on Δb than a similar change in carbon. This postulate can thus give a qualitative explanation of the phenomena resulting from isotopic replacement in molecules containing shielded central atoms. Moreover, as a further consequence, it would predict a big change in Δb when any particularly strong intermolecular interaction is involved or when isotopes of small mass are exchanged, and it will be shown elsewhere that this is in accord with experimental observations. In fact, the results of Kuhn *et al.* on methanol provide an example of this behaviour. Thus, for carbon exchange the heavy species is more volatile, whereas in oxygen exchange the heavy species is less volatile. This comparison is complicated by the fact that oxygen exchange involves twice the change in mass for carbon exchange, but no such difficulty arises in comparing carbon exchange with hydrogen exchange. According to the above theory, CH_3OH should be more volatile than CH_3OD because of the great change in zero-point energy caused by hydrogen

exchange on the strong H...O interactions, and this is confirmed by the experimental results.

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¹ Baertchli, P., Kuhn, W., and Kuhn, H., *Nature*, 171, 1018 (1953).

² Hinselwood, C. N., "The Structure of Physical Chemistry", 142 (Oxford, 1951).

Mechanism of the Bursting of Bubbles

THE formation of drops, as the result of a gas or vapour bubble bursting at the surface of water, has been attributed to the break-up of the jet formed when liquid flows into the crater left by the burst bubble, and photographic evidence indicates that large drops are, in fact, formed in this way¹.

We have observed, however, that two separate mechanisms are involved in the bursting of a bubble—



Fig. 1

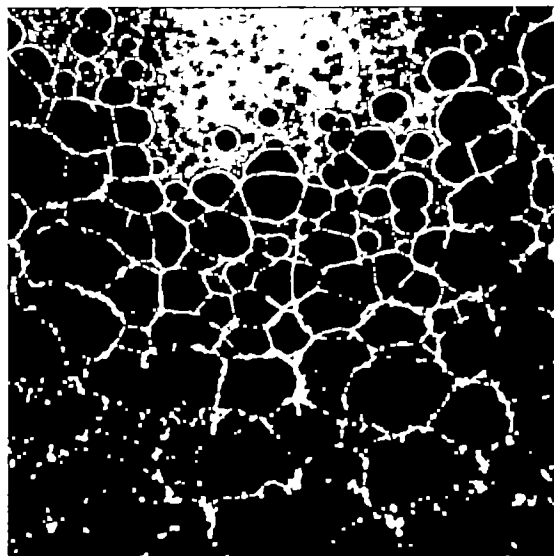


Fig. 2

one producing a cloud of droplets of diameter about 60 microns, and the other a few comparatively large drops of diameter about 1 mm. The various stages of the collapse are illustrated in Fig. 1, a-f. It will be observed that in the initial stage a protuberance develops on the hemispherical surface of the bubble, (b), the collapse of which produces the cloud of fine droplets and leaves a large gap in the bubble envelope (c). The escape of gas through this gap effectively disperses the cloud and imparts to the droplets a high velocity. Thereafter a crater is formed at the site of the bubble (d), and the incoming rush of liquid produces an unstable jet (e), which breaks up into one or more large drops (f).

Fig. 2 illustrates the way in which a thin film of liquid disintegrates to give the fine droplets observed in the initial stage of the burst.

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¹ Woodcock, A. H., Klenzian, C. F., Arons, A. B., and Blanchard, D. O., *Nature*, 172, 1145 (1953).

A Long Spacing at about 30 kX. confirmed from a Fireclay

THE white clay from the Kurata Mine, Yamaguchi Prefecture, Japan, is largely composed of kaolinite; in flinty massive specimens it is commonly well crystallized, whereas in powdery massive specimens it is disordered. The clear resolution of the (111), (111) doublet is revealed in X-ray powder reflexions of a certain flinty specimen. The disordered behaviour is marked by a band of the two-dimensional type associated with (020). These facts were first reported by G. W. Brindley and K. Robinson for specimens from England. It is noteworthy in the present case that reflexions from the latter type are frequently accompanied by those of montmorillonite as well as a clear powder reflexion at $29.8 (\pm 0.5)$ kX. The basal reflexions of the montmorillonite are

14.7 (± 0.2) kX. (001), 4.93 kX. (003) and 2.97 kX. (005), and of the kaolinite, 7.13, kX. (001), 3.58 kX. (002) and 2.40 kX. (003). The intensity of the 14.7 line is commonly proportional to that of the 29.8 kX. line; but the ratio of the intensity of the kaolinite line to that of montmorillonite varies from specimen to specimen. The (060) spacing is 1.491, kX., which suggests that the amount of aluminium replacing silicon is small.

The reference specimens were ignited at temperatures of 300°, 500°, 700°, 900° and 1,100° C. for one hour and cooled and studied by X-rays immediately after cooling. The X-ray powder pattern was not affected by heating at 300° C. At 500° C., kaolinite lines as well as the 29.8 kX. line had disappeared; montmorillonite lines remained weak and unchanged except the 14.7 kX. line, which was replaced by a line at 11.7 (± 0.2) kX. The powder pattern at 700° C. agrees perfectly with that obtained at 500° C., that is, the 11.7 kX. line is persistent even at 700° C. At 900° C. most of the powder lines are just visible; mullite lines are revealed in the pattern obtained by heating at 1,100° C. Thus the usual 9.6 kX. line of dehydrated montmorillonite never appeared in the temperature range investigated.

Treatment with ethylene glycol caused the 14.7 kX. line to be replaced by a 15.6 (± 0.3) kX. line, and the 29.8 kX. line by a 32.3 (± 0.5) kX. line. Treatment with water expanded the 14.7 kX. spacing to 16 kX., and the 29.8 kX. spacing to 32-33 kX.

A specimen ignited at 700° C. was cooled and sealed in a glass tube immediately. At the beginning of the X-ray experiment, the specimen was transferred from the glass tube to a shallow cell on the slide glass containing phosphorus pentoxide to prevent adsorption of moisture into the specimen during X-radiation. Even with this treatment the 11.7 kX. line is still persistent at 700° C. To prevent the effect of exchangeable cations, the clay was electrolysed and studied by X-rays at room temperature. The X-ray powder pattern thus obtained agrees perfectly with that of the original specimen.

To account for these unusual X-ray properties, three types of lattices can be considered: (1) kaolinite; (2) the usual montmorillonite lattice with two sheets of water molecules (*M*-lattice), with a cell height of 15.4 kX., which is expected to decrease to 9.6 kX. by heating at least at 300° C., and to expand to 17.0 kX. with ethylene glycol treatment; (3) an unusual lattice (*G*-lattice) showing a configuration represented by a gibbsite layer interleaved between two adjacent silicate layers (pyrophyllite units); its cell height approximates to 14.0 kX., which is expected to be unaffected by the treatments with ethylene glycol and water, and may be persistent at least up to 700° C.

Thus it is considered that the 14.7 kX. line is caused by a mixed-layer structure containing the *M*-lattice and the *G*-lattice; this line is expected to expand to 15.6 kX., when the *M*-lattice expands to 17.0 kX. by treatment with ethylene glycol, and to decrease to 11.7 kX. when the *M*-lattice contracts to 9.6 kX. by dehydration. The long spacing

of 29.8 kX. is considered to be caused by a super-lattice composed of these two lattices. It may be expected that the super-lattice will be completely destroyed at the same time as the *M*-lattice becomes dehydrated.

We are indebted to Prof. G. W. Brindley for discussion of this problem.

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¹ Brindley, G. W., and Robinson, K., *Mineralog. Mag.*, **37**, 242 (1946).

Effect of Previous Stress-Strain History on the Dynamic Hysteresis Loop for Rubber in Compression

SEVERAL investigators have shown that the behaviour of rubber is affected appreciably by its previous stress-strain history. Their observations, in the main however, are based on indirect measurements of modulus and damping characteristics. Few, if any, have recorded stress-strain relationships in these investigations. Although it might be possible to calculate, from these indirect measurements, the slope and area of the dynamic hysteresis loop; such measurements give no indication of the position of the hysteresis loop relative to the axes of stress and strain. The position of the loop is of fundamental importance in assessing the dynamic characteristics of rubber, and plays a big part, for example, in determining the resilience of the material. To the best of our knowledge, little, or nothing, is known of the effect of previous stress-strain history on the position of the dynamic hysteresis loop, and it is felt that the test record presented below may be of immediate interest to workers in this field. The record forms part of a major investigation which it is hoped to publish later.

The test recorded in Fig. 1 consisted of several hysteresis loops carried out at constant frequency, each about a different mean deformation. The mean

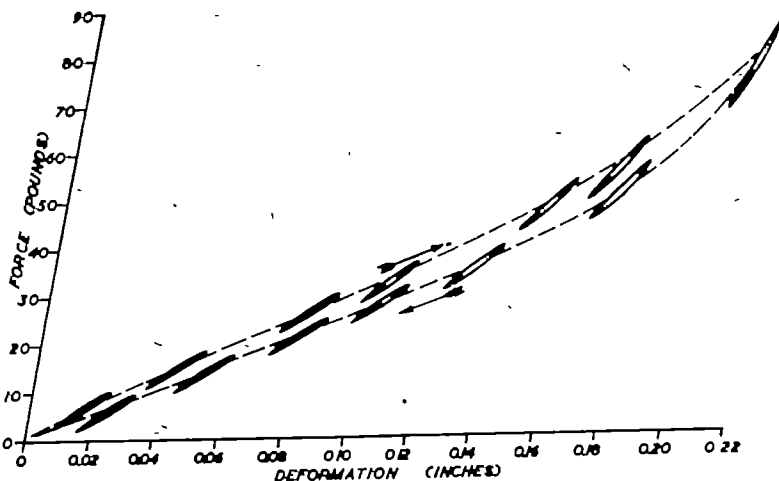


Fig. 1. Effect of previous history. Small loops at 100 c./m.; dotted loop at 1 c./15 min.

deformation was increased in increments up to a predetermined maximum, and then reduced to zero. It will be seen that the loops recorded on the 'return path' do not coincide with those on the 'outward path'. This difference persisted even when an interval of up to 30 min. was allowed after each adjustment of the mean deformation before recording the loop in question. The small hysteresis loops lie on the periphery of a larger loop which was recorded over the same range of deformation. This larger loop was performed very slowly—the rate being 1 cycle in 15 min. It would appear from these results that the so-called 'history effect' is but another manifestation of hysteresis.

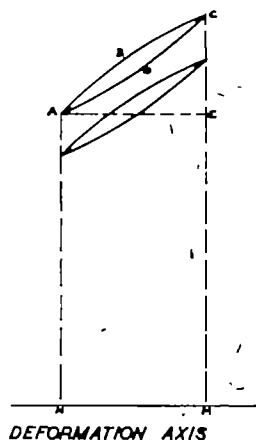


Fig. 2

The test was repeated with dynamic loops of larger amplitude from which measurements could be made of area and slope. No difference could be detected in either the areas or slopes of loops recorded at corresponding mean deformations over much of the outward and return paths.

The results presented here have a bearing on some previous observations concerning the terms resilience and percentage damping¹. The term percentage damping—defined as the ratio of the loop area $ABCD$ (Fig. 2) to the area $ABCE$ —does not permit quantitative measurements to be made of the movement of the loop, since the line AE is not a fixed reference line but moves with the loop. The term resilience, on the other hand—defined for the upper loop as the ratio of area $NADCM$ to $NABCM$ —will theoretically permit a quantitative assessment to be made of the shift of the loop. In practice, however, since the areas involved are comparatively large and almost equal, the term resilience does not bring out the difference between the upper and lower loops. Therefore, before any quantitative work can be attempted on the effect of stress-strain history, the definition of some suitable means of measuring the effect must be agreed upon.

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¹ Davies, D. M., *Nature*, 170, 937 (1952).

Regularities in the F_2 -Region of the Ionosphere

THE variation of the maximum ionization density ($N_{\max} F_2$) of the F_2 -region of the ionosphere is known generally to depart widely from the $\sqrt{\cos \chi}$ law of Chapman (where χ is the zenith distance of the sun). It has, however, been recently shown by Ratcliffe¹ that if, instead of $N_{\max} F_2$, the total ion content (per unit cross-section) of the F_2 -region ($n_T F_2$) be considered, the variations of the total ion content with $\sqrt{\cos \chi}$ appear to be more regular. I have followed up this view², and have shown that if, in place of

$n_T F_2$, the total ion content of the F_1 - and F_2 -region as a whole (n_T) is considered, then the variations of n_T with $\sqrt{\cos \chi}$ become very much more regular. However, it was observed that on these otherwise regular variation curves (diurnal and seasonal) certain abnormal peaks are superposed. I had provisionally explained these as due to the effects of solar tides, superposing themselves on the variations due to changes in the zenithal position of the sun. In order to check this assumption seasonal variation curves of the monthly mean values of the 24-hr. average total ion content (n_T) were plotted (Figs. 1 a, b, c). These seasonal variation curves—from which the solar tidal effects are obviously eliminated—are found to closely follow the corresponding $\cos \chi$ curves, justifying the assumptions made. The data analysed were for the same three stations—Slough, Falkland Islands and Singapore—as had been studied in the earlier work.

These results also support the recent hypothesis³ that the F_1 - and F_2 -regions are formed by a common ionizing process (ionization of oxygen at its first ionization potential), and that in the single bank of ionization so formed there is produced, besides the

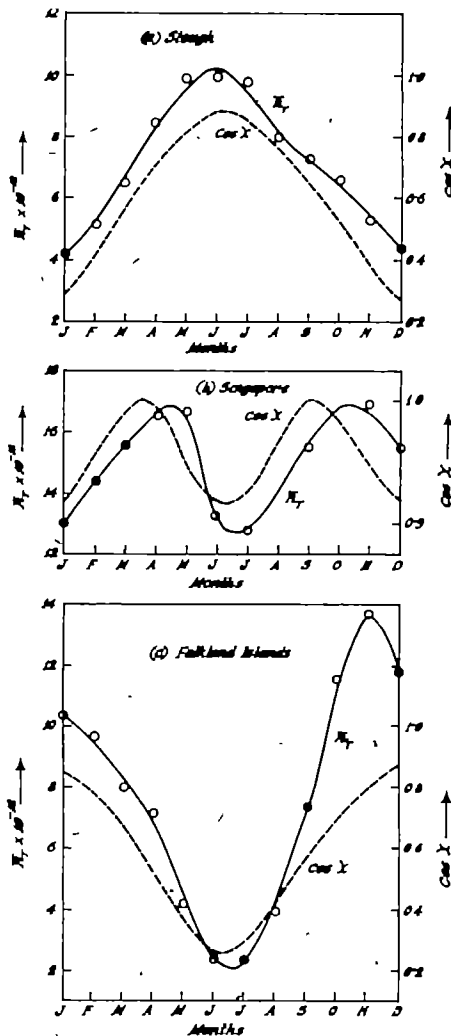


Fig. 1. Seasonal variation curves of the monthly mean values of n_T and $\cos \chi$ in 1951 (χ is the noon-time zenith angle of the sun)

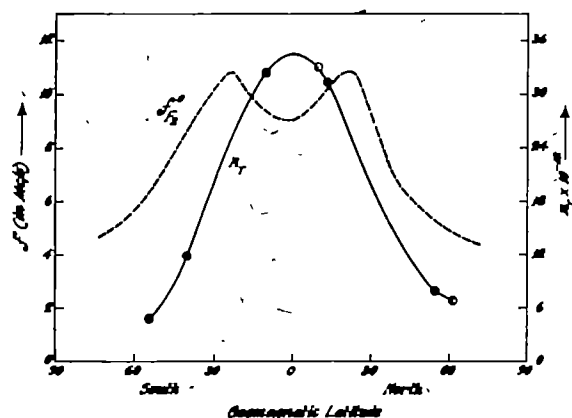


Fig. 2. Variation with latitude of the monthly mean noon values of $f°F_1$ and n_+ for April 1953

usual Chapman maximum F_1 , a secondary maximum F_2 higher up, due to the peculiar physical characteristics of the region above F_1 -maximum.

An interesting fact regarding the latitudinal variation of the monthly mean values of noon-time total ion content was also noticed. The curve in Fig. 2 shows that, unlike the curve depicting the latitudinal variation of noon-time $f°F_1$ (dotted), that of the total ion content does not show the 'Appleton dip' around the geomagnetic equator. However, the maximum occurs on the geomagnetic equator rather than on the geographic equator, showing that the distribution of even the total ion content of the F_1 - and F_2 -regions is subject to geomagnetic control.

My thanks are due to Prof. S. K. Mitra for his guidance and interest in the work. Thanks are also due to the Scientific Man-Power Committee, Government of India, for financial help.

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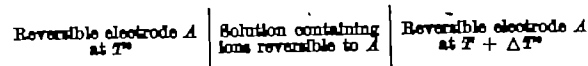
¹ Ratcliffe, J. A., *J. Geophys. Res.*, **56**, 463 (1951).

² Chatterjee, B., *J. Geophys. Res.*, **58**, No. 3 (1953).

³ Bates, D. R., and Mamey, H. B. W., *Proc. Roy. Soc. A*, **187**, 261 (1946). Mohler, F. L., *Bur. Stand. J. Res.*, **55**, 507 (1940).

Thermal Diffusion Potentials and the Soret Effect

WHEN a temperature gradient is applied to a homogeneous solution of an electrolyte, there is a tendency for a concentration gradient to be established (Soret effect). The thermal diffusion potential associated with the temperature gradient should change during the establishment of the Soret equilibrium. For a cell of the type:



the change in e.m.f. during the establishment of this equilibrium can be calculated theoretically¹⁻³. In the simplest case³, where the solution contains a uni-univalent salt obeying the ideal law, the change in e.m.f., $\Delta\epsilon$, for a cell containing electrodes reversible to anions is

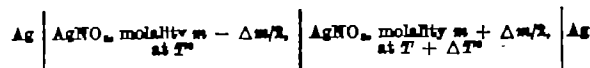
$$\Delta\epsilon = -2RT/F \cdot n_+ d/dT (\ln m); \quad (1)$$

and, for one with cation-reversible electrodes,

$$\Delta\epsilon = +2RT/F \cdot n_- d/dT (\ln m); \quad (2)$$

where an increase in concentration at the hot electrode is taken as positive, and n_+ and n_- represent the transference numbers of the cation and anion respectively.

Conditions suitable for the establishment of the Soret effect are not easily attained, and earlier experiments³ designed to provide a test of the above equations were only partially successful. The difficulty of verifying these equations, though not of determining Soret coefficients, may be overcome by a modification of the technique used in this laboratory for the measurement of thermoelectric e.m.f. values at the time of the establishment of the thermal gradient³. Using cells of substantially the same design as those used previously, we have measured the e.m.f. ($\Delta\epsilon$) of the cell:



and compared it with that found for an identical system with a solution of molality m in contact with both electrodes. The results obtained in the two cases so far examined are shown in Table 1.

The mean temperature in these experiments was approximately 29°C. The values of $d\epsilon/dT$ for a cell with no concentration gradient were obtained by interpolation from the results of independent experiments⁴.

The experimental values have the sign predicted by equation (2) and, in the second case, the numerical agreement is excellent. In the first, the discrepancy between the observed and the calculated value is considerably greater than the experimental error in the e.m.f. measurements, and the experimental value requires confirmation.

Clearly, this method permits the investigation of deviations from the ideal equations shown above, and suggests a new method of investigating the Soret effect. An empirical knowledge of the relation $\Delta\epsilon$ and $d\epsilon/dT (\ln m)$ would enable Soret coefficients to be calculated from measurements of $\Delta\epsilon$ in cells in which the Soret equilibrium is established between plane parallel electrodes the surface temperature of which is known accurately. This method is not limited to the rather high concentrations employed in earlier work in this field³, and measurements in

Table 1

m (mol./1,000 gm. solution)	Δm (mol./1,000 gm. solution)	ΔT (°C.)	$d\epsilon/dT$ (μ volt/°C.)	$1/m \cdot \Delta m / \Delta T$ $\times 10^3$	$\Delta\epsilon$ (exp.) (μ volt/°C.)	$\Delta\epsilon$ (calc.) (μ volt/°C.)
0.00948	Zero	—	— 600	— 1.0	— 71	— 23
0.00948	— 0.00044	4.40	— 690	—	—	—
0.00928	Zero	—	— 600	— 21.1	— 595	— 589
0.00928	— 0.00015	4.26	— 1,204	—	—	—

dilute solutions should prove of considerable interest in the theoretical interpretation of the Soret effect.

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¹ de Groot, *J. Phys. et Is Rad.*, **8**, 129 (1947).

² Tyrrell and Hollis, *Trans. Farad. Soc.*, **48**, 503 (1952).

³ Haase, *Trans. Farad. Soc.*, **49**, 724 (1953).

⁴ Colledge, thesis, University of Sheffield (1953).

⁵ cf. Tanner, *Trans. Farad. Soc.*, **53**, 75 (1927); **49**, 611 (1953).

Anhydrous Hydrogen Fluoride as a Solvent for Proteins

ANHYDROUS hydrogen fluoride (m.p., $-83^{\circ}\text{C}.$; b.p., $19.5^{\circ}\text{C}.$) has been found to be a powerful solvent for a wide variety of proteins. Experiments were carried out in transparent tubes moulded or machined from polychlorotrifluoroethylene polymer; these tubes containing the intensively dried protein samples could be attached to a metal vacuum system, hydrogen fluoride added by distillation, and direct visual observations made in the absence of moisture. Among proteins which are readily soluble in hydrogen fluoride at 0° are ribonuclease, lysozyme, pepsin, trypsin, crystallized egg albumin, bovine plasma albumin, bovine plasma globulin, edestin, peanut protein globulin, casein, zein, silk fibroin, hide collagen, insulin and adrenocorticotrophic hormone. These are all soluble at least to the extent of 20 mgm. per ml., and much more concentrated solutions can in general easily be prepared. Thus, a solution containing 350 mgm. per ml. bovine plasma albumin is still quite fluid at $0^{\circ}\text{C}.$ The solutions are clear, colourless to faint amber, and are very much less viscous than corresponding aqueous solutions. The globular proteins dissolve rapidly even at $-78^{\circ}\text{C}.$, whereas silk fibroin and hide collagen undergo strong swelling and require many hours at room temperature for complete solution.

The iron-containing proteins cytochrome c, catalase and haemoglobin are very soluble in hydrogen fluoride. They give pink solutions which have absorption spectra very similar to those exhibited in water. The ability of metal-complex compounds to exist in hydrogen fluoride appears to be a general phenomenon, for it is found that metal phthalocyanines, cobalt(III)amine-complex compounds, and a considerable variety of other metal-complex compounds dissolve in hydrogen fluoride without precipitation of metal fluoride.

Proteins were recovered by evaporation of the solutions on the vacuum line. Films of recovered silk fibroin and collagen gave characteristic polypeptide infra-red spectra. Of the proteins mentioned above, ribonuclease, lysozyme, trypsin, cytochrome c, haemoglobin, hide collagen, insulin and adrenocorticotrophic hormone are recovered in a water-soluble state after remaining in hydrogen fluoride solution for 2 hr. at $0^{\circ}\text{C}.$ Recovered insulin was found by bioassay on mice to have retained 80 per cent of its initial activity, and similarly adrenocorticotrophic hormone was recovered intact with full retention of its original biological activity. The biological properties of the other water-soluble proteins after recovery remain to be examined. The surprising retention of biological activity by insulin

and adrenocorticotrophic hormone after dissolution and recovery from hydrogen fluoride solution suggests that this solvent may have real significance in protein studies.

Because of its low freezing point, liquid hydrogen fluoride may be an interesting medium for carrying out chemical reactions on proteins at very low temperatures. For example, it has been observed that ozone, which appears to be quite soluble in hydrogen fluoride, changes a pink haemoglobin solution to green. Hydrogen peroxide solutions in hydrogen fluoride (prepared by addition of the 1:1 urea-hydrogen peroxide addition compound) change the pink colour of cytochrome c and catalase solutions to yellow. Trioxane, which has been found to be highly soluble in hydrogen fluoride, gives a typical formaldehyde reaction when added to a protein dissolved in hydrogen fluoride; the viscosity of the solution increases until a rigid gel results. These and other characteristic protein reactions with many of the usual protein reagents can thus be carried out at much lower temperatures than has been possible in aqueous systems.

Details of these experiments will appear elsewhere.

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Formation of a Mixed Disulphide of Cysteine and Glutathione

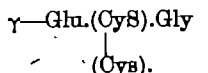
In our studies on the synthesis of glutathione by *Saccharomyces cerevisiae*, the yeast was incubated in 0.01 M potassium dihydrogen phosphate with cysteine containing sulphur-35. Samples of the mixture were removed at intervals and the component amino-acids and peptides were separated by paper chromatography. The chromatograms were sprayed with a ninhydrin solution and autoradiograms of the chromatograms were made on Kodak No-screen X-ray film.

When a phenol-water mixture was used for preparing a descending chromatogram, a spot which contained a considerable amount of sulphur-35 was observed. This substance ($R_F = 0.27$) was intermediate between glutathione disulphide ($R_F = 0.16$) and cystine ($R_F = 0.42$). It was found in largest amounts in the mixture of yeast and sulphur-35 cysteine immediately after the cysteine had been added to the yeast and before it had been metabolized by the cells to any extent. Since both cysteine and glutathione are oxidized to the disulphides during chromatography under our conditions, it seemed possible that the new substance was a mixed disulphide of cysteine and glutathione formed not by the yeast but by oxidation by the air. The intermediate compound was shown, indeed, to be a disulphide by the use of Toennies's reagent¹.

Further evidence supporting the view that this compound was a mixed disulphide of cysteine and glutathione and that it was formed in the absence of yeast cells was obtained by mixing cysteine and glutathione in aqueous solution in the absence of yeast cells and also by using cysteine or glutathione labelled with radioactive sulphur. A solution of sulphur-35 cysteine was mixed with non-labelled glutathione in the absence of yeast cells, and this mixture was chromatographed immediately after being prepared.

Again three substances which reacted with ninhydrin and which had the R_f values mentioned above were found. Cystine and the intermediate spot were shown by an autoradiograph of the paper chromatogram to contain sulphur-35, while the glutathione disulphide spot did not. By counting the filter paper chromatogram with a thin end-window Geiger-Müller tube, it was found that 30 per cent of the sulphur-35 cysteine was incorporated into the intermediate compound when the initial solution contained equimolar amounts of sulphur-35 cysteine and glutathione.

A similar experiment was carried out with glutathione containing sulphur-35 and non-labelled cysteine. When the sulphur-35 glutathione and cysteine were mixed in solution and the mixture chromatographed, the intermediate disulphide spot again appeared. This substance and glutathione disulphide were shown to be radioactive whereas the cysteine spot was not. It was concluded, therefore, that this material was most probably a mixed disulphide of cysteine and glutathione:



Wikberg² has reported the formation of a mixed disulphide of glutathione and cysteinylglycine when glutathione was partially hydrolysed. His mixed disulphide was separated by paper electrophoresis from cystine and glutathione disulphide. He also reported the preparation of a mixed disulphide of cysteine and glutathione by oxidation with perhydrol at pH 7.5.

The results reported here were discussed before the American Chemical Society Meeting at Los Angeles in March 1953.

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¹ Toennies, G., and Kolb, J. J., *Anal. Chem.*, **23**, 823 (1951).

² Wikberg, Bakli, *Nature*, **173**, 398 (1953).

A Method for the Cleavage of 2,4-Dinitrophenylhydrazones and Its Application to Steroidal Ketones

2,4-DINITROPHENYLHYDRAZONES have proved very useful derivatives for identification purposes, but have so far found only limited application in preparative work. This is due to the fact that there exists no general method for the regeneration of the corresponding carbonyl compounds. As Djerassi pointed out¹, the failure to cleave 2,4-dinitrophenylhydrazones has imposed considerable limitations on the use of the Mattox-Kendall² dehydrobromination method in the field of steroid chemistry. Thus, in the case of 2,4-dinitrophenylhydrazones of $\Delta^{1,4}$ -dien-3-ketosteroids, only about 5-10 per cent of ketone could be recovered after treatment with pyruvic acid and hydrobromic acid, and derivatives of $\Delta^{1,4}$ -dien-3-ketosteroids could not be split at all¹.

We have now found that the splitting of these 2,4-dinitrophenylhydrazones can be achieved in good yields by the following general procedure, the quantities and times required for saturated-, Δ^1 , and Δ^4 -3-ketosteroids being denoted by (a), and those for $\Delta^{1,4}$ and $\Delta^{4,6}$ -3-ketosteroids by (b). The 2,4-dinitrophenylhydrazone (1 gm.) is dissolved in acetone

(a, 200 c.c.; b, 500 c.c.) containing concentrated hydrochloric acid (a, 5 c.c.; b, 10-20 c.c.) and the solution is refluxed (a, 45 min.; b, 7-8 hr.); this displacement can also be brought about at ordinary temperature for 2,4-dinitrophenylhydrazones of class (a) (24 hr.) and for the more soluble derivatives of class (b) (15 days). The yellow to orange-yellow solution is slightly cooled and treated with stannous chloride (5 gm.) dissolved in concentrated hydrochloric acid (20 c.c.). Water (a, 30 c.c.; b, 80 c.c.) is added and the mixture heated to reflux in an atmosphere of nitrogen for 45 min.; further heating decreases the yield and purity of the ketone recovered. With 2,4-dinitrophenylhydrazones of both classes, this reduction can be carried out at ordinary temperature (24 hr.). The acetone is distilled off under reduced pressure at room temperature, the residue extracted with benzene, and the organic layer washed with 1 N hydrochloric acid until no more coloured material is removed. The benzene solution is finally washed with water and evaporated. The recovered ketone is purified by the usual methods.

Using this procedure the following results were obtained with approximately 1 gm. each of 2,4-dinitrophenylhydrazones:

- (1) Δ^1 -cholestan-3-one: yield, 98 per cent (m.p., 127-128°; lit., 129-130°).
- (2) Δ^4 -cholestan-3-one: yield, 96 per cent (m.p., 78-79.5°; lit., 80-8°).
- (3) Δ^1 -cholestan-3-one: yield, 84 per cent (m.p., 99-100° (from dil. alcohol); lit., 98-100°).
- (4) Testosterone: yield, 98 per cent (m.p., 143-150°; lit., 153°).
- (5) Progesterone (via 2,4-dinitrophenylhydrazone): yield, 86 per cent (m.p., 120° (from pet. eth.); lit., 121°).
- (6) $\Delta^{1,4}$ -cholestan-3-one: yield, 83 per cent (m.p., 110-111°; lit., 113°).
- (7) $\Delta^{4,6}$ -cholestan-3-one: yield, 88 per cent.
- (8) Methyl $\Delta^{1,4}$ -3-ketostrioladienate: yield, 67 per cent (m.p., 153-155°; lit., 156°).

As it is somewhat difficult to purify $\Delta^{4,6}$ -cholestan-3-one on a small scale, the yield was determined by reconstituting it into the corresponding 2,4-dinitrophenylhydrazone (m.p. 234° from acetic acid).

The successful cleavage of the $\Delta^{1,4}$ -dien-3-one derivatives supports Djerassi's assumption that they are true hydrazones and not pyrazoline derivatives (cf. ref. 1, footnote 19, p. 1005).

The final benzene solution of methyl $\Delta^{1,4}$ -3-ketostrioladienate was extracted with sodium bicarbonate solution. On acidification this gave 110 mgm. of an acid (m.p. 277-280° with dec.), showing that partial hydrolysis of the ester group had occurred.

Other ketones, such as dibenzyl acetone, have also been recovered successfully by this treatment.

We suggest that the method is of wider application and that it may be useful in other fields of preparative organic chemistry.

We wish to express our thanks to Dr. Carl Djerassi, to the CIBA, S.A. (Basle) and to the Schering A.G. (Berlin) for gifts of specimens which have greatly facilitated this work. Full details of this investigation, including improvements in the preparation and purification of some 2,4-dinitrophenylhydrazones of 3-ketosteroids, will be published in the *Bull. Soc. Chim. Belg.*

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¹ Djerassi, C., *J. Amer. Chem. Soc.*, **71**, 1003 (1949).

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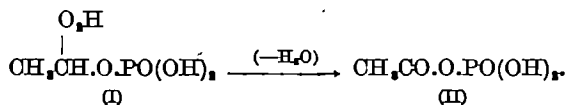
Formation of Acetyl Phosphate by the Action of X-Rays on Monoethyl Phosphoric Acid in Aqueous Solution

Our earlier work on the chemical action of X-rays on the nucleic acids in aqueous systems¹ has led us to suggest that labile compounds, including labile phosphate esters, are formed on irradiation, and that these may play some part in the breakdown of the polynucleotides. Following some observations on the effects of the radiation on relatively simple phosphate esters (for example, glycerophosphates, phosphoglyceric acid), we have suggested that, in general, oxidative attack at a $> \text{CH}(\text{OH})$ (secondary alcohol) group by the free radicals can lead to the formation of a $> \text{C}=\text{O}$ (carbonyl) group, and that, if the latter is α - or β - to a phosphate group, a more or less labile ester is produced².

In order to elucidate further the chemical mechanism by which labile phosphate esters are formed in these circumstances, a systematic investigation of the effects of X-rays on a number of phosphate esters has been undertaken.

We are now reporting some observations on one of the simplest phosphate esters, namely, monoethyl phosphoric acid. Here one might expect that oxidative attack by the radicals on the primary phosphoryl group ($-\text{CH}_2\text{OPO}(\text{OH})_2$) would lead, by a relatively straightforward process, to the corresponding aldehyde, together with inorganic phosphate. On the other hand, we may apply, in the presence of oxygen, a mechanism which we have recently found to be operative in the attack on certain simple aliphatic compounds³; this involves reaction of the organic radical primarily formed with molecular oxygen, which can lead to an organic hydroperoxide.

In the case of monoethyl phosphoric acid, the hydroperoxide resulting from attack on the primary phosphoryl group would have structure (I), subsequent decomposition of which could lead to acetyl phosphate (II):



We have now demonstrated that this latter mechanism does, in fact, also hold for this system, since we have been able to show that irradiation of monoethyl phosphoric acid with X-rays in the presence of oxygen gives acetyl phosphate, among other products. This conclusion is based on the following experimental evidence.

(i) Slow liberation of inorganic phosphate after irradiation.

(ii) A positive Lipmann reaction⁴ for acetyl phosphate, namely, formation of the corresponding hydroxamic acid which gave the characteristic ferric salt in acid solution (ferric acetylhydroxamate was identified by its absorption spectrum).

(iii) A difference in the yields of inorganic phosphate as determined separately by the methods of Lowry and Lopez⁵ and Berenblum and Chain⁶; whereas the former is suitable for the determination of inorganic phosphate in the presence of acetyl phosphate⁷, under the conditions of the Berenblum-Chain procedure, it is known that acetyl phosphate is rapidly hydrolysed⁸.

A typical experiment was as follows: 100 ml. of a solution of monoethyl phosphoric acid (0.1 per cent calcium salt), adjusted to pH 5.5 and saturated with

oxygen (1 atm.), were irradiated with X-rays (200 kV.) with a total dose of 7×10^4 r. (integral dose-rate = 2,840 r./min.). Under these conditions, 15 μ moles of acetyl phosphate per 100 ml. were produced. At the same time, some acetaldehyde was formed and about 5 μ moles of inorganic phosphate; somewhat more inorganic phosphate than acetaldehyde is to be expected, owing to the slight decomposition of the acetyl phosphate during irradiation.

These results show that one of the major processes occurring under these conditions is that leading to acetyl phosphate. In agreement with the mechanism outlined above, we have found that the formation of acetyl phosphate requires the presence of molecular oxygen.

These observations would suggest that certain other compounds containing the primary phosphoryl group ($-\text{CH}_2\text{OPO}(\text{OH})_2$) may give, on irradiation in the presence of oxygen, the corresponding acyl phosphate to a smaller or greater extent.

Thus, labilization of organic phosphate esters can be due to the production of carbonyl groups (α - or β - to the phosphate) and/or, under certain conditions, to the formation of acyl phosphates. Carbonyl groups can be produced by OH radicals (generated by the action of the ionizing radiation on water, namely, $\text{H}_2\text{O} \rightsquigarrow \text{H} + \text{OH}$), and their formation is therefore not dependent upon the presence of oxygen in solution, although, for reasons discussed previously^{3,4}, oxygen should, in general, enhance the yield of the carbonyl compound. On the other hand, for the formation of the acyl phosphate, as described above, the presence of molecular oxygen is essential.

This appears to be the first instance in which acetyl phosphate is formed by a relatively simple oxidation process in aqueous solution.

Our thanks are due to the Northern Council of the British Empire Cancer Campaign and to the Rockefeller Foundation for financial support.

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¹ Scholas, G., and Weiss, J., *Nature*, **186**, 640 (1950); *Exp. Cell Research*, **Supp.** **2**, 219 (1953); *Biochem. J.*, **53**, 567 (1953); **56**, 66 (1954).

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A Trough for Paper Chromatography consisting of Segments

The sensitivity of paper chromatography is such that lack of reproducibility often hampers the systematic approach. In order to facilitate measurements under identical conditions, we are using a glass trough which consists of four equal segments.

Each segment can hold duplicate strips of paper of 7 cm. $\times$ 40 cm., or one can apply two sheets of paper of 40 cm. $\times$ 40 cm. if three small cuts are made on the top edge (see Fig. 1). To mark the movement of liquid flowing from one segment, 1 c.c. of

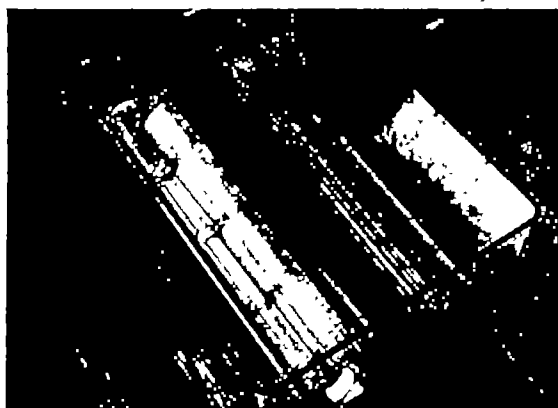


Fig. 1. Apparatus for descending paper chromatography with a trough consisting of four segments

10⁻³ M quinine sulphate is added to segments 1 and 3; after the paper has been dried, fluorescence shows clearly the borders of the solvents flowing from each segment. If the position of the trough is exactly horizontal, these borders are found to be perfectly vertical to the axis of the trough. We can thus establish a pH gradient on a paper, when each segment contains a buffered solvent system of a slightly different pH. When this technique is applied to protein hydrolysates as a second run (first run with propanol/water 7:3), it is possible to accelerate or to slow down the movement of amino-acids with polar groups; in many instances incomplete separation can be overcome.

The following example demonstrates the effect of a variation of the ionic strength of the buffer system on the separation of arginine, lysine and glutamic acid. The solvent system *m*-cresol/phenol 1:1 was used as described by Levy and Chung¹; 0.1 M potassium dihydrogen phosphate/0.05 M sodium borate of pH 9.0 and of varying ionic strength was added as buffer. The run lasted for 17 hr. at 18° on Whatman No. 1 paper. One paper of 40 cm. × 40 cm. was used, and at the end it was cut into four equal strips for photography. The colour was developed with ninhydrin according to the method of Moore and Stein².

Besides the *R_F*-values, we give in Table 1 the planimeter value of the areas of the spots. We are using the latter as a measure of the compactness of spots; but we do not consider them to allow a quantitative evaluation of single amino-acids as has been suggested elsewhere.

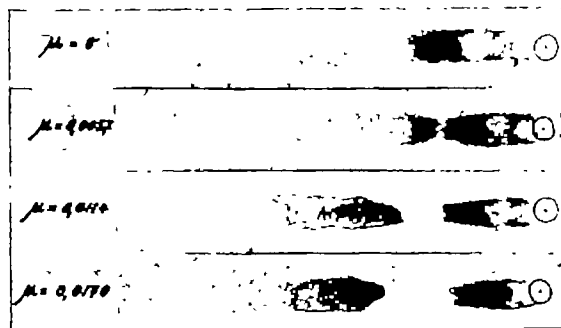


Fig. 2. One-dimensional chromatograms showing the influence of an increase of the ionic strength of the borate buffer on the same paper under identical conditions

Table 1

μ	Ionic strength of borate buffer							
	0.0000		0.0067		0.0114		0.0170	
	<i>R_F</i>	PI*	<i>R_F</i>	PI*	<i>R_F</i>	PI*	<i>R_F</i>	PI*
Arginine	0.37		0.33	1.00	0.34	0.41	0.37	0.30
Lysine			0.21	0.17	0.28	0.15	0.30	0.13
Glutamic acid	not sep.		0.14	0.53	0.13	0.46	0.10	0.37

* Planimeter reading.

Thus an increasing ionic strength of the borate buffer leads to an improved separation of basic and acidic amino-acids, as well as to more compact spots.

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¹ Levy, A. L., and Chung, D., *Anal. Chem.*, **25**, 896 (1953).

² Moore, S., and Stein, W. H., *J. Biol. Chem.*, **176**, 367 (1948).

Bicarbonate Content of the Blastocyst Fluid and Carbonic Anhydrase in the Pregnant Rabbit Uterus

It has been noted in the course of a chemical investigation of the properties of rabbit blastocysts that the fluid which fills the cavity of the blastocyst at six and seven days after mating turns distinctly alkaline after withdrawal and standing in air for a few moments, whereas at eight days, in similar circumstances, the reaction of the fluid remains practically unaltered, at pH 7.8¹. In view of the low buffering capacity of the fluid obtained from six- and seven-day old blastocysts, it was thought likely that bicarbonate may be responsible for the shift in the pH value. Accordingly, manometric determinations were carried out in samples of fluid from blastocysts at six, seven and eight days after mating, collected by means of a technique described elsewhere¹.

The results of the manometric experiments have justified our assumption: a remarkably high content of bicarbonate, three times that present in maternal serum, was found in the unimplanted six-day old blastocysts; at seven days, when the majority of the blastocysts are in the process of incipient implantation, it was less, but there was still a considerable amount of bicarbonate in the fluid; on the other hand, at eight days, when implantation is complete, the level of bicarbonate was somewhat below that recorded for maternal blood (Fig. 1). As a matter of interest, it may be added here that we have also examined the bicarbonate content in cow ovarian follicle fluid from early luteal phases², and in cow and pig allantoic and amniotic fluids (at twenty-nine and twenty days of pregnancy, respectively); except for the pig allantoic fluid, which at that stage appeared to lack bicarbonate, the other fluids exhibited bicarbonate values close to those found in blood plasma.

The occurrence of bicarbonate in a high concentration in the early blastocysts has led us to investigate the presence of carbonic anhydrase in the uterus. The uterine mucosa was collected from thoroughly bled six- and seven-day pregnant does, and also from non-pregnant rabbits, and assays of carbonic anhydrase activity were carried out in saline-phosphate extracts from the mucosa, by means of the colorimetric³ and boat⁴ methods. It was found that the

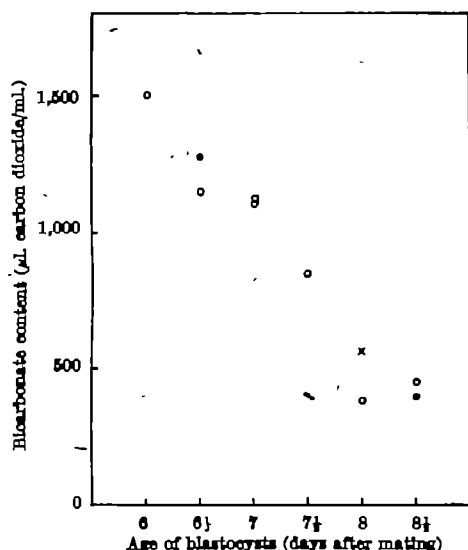


Fig. 1. Bicarbonate content in the rabbit blastocyst fluid: O, blastocyst fluid; X, maternal serum

non-pregnant uterine mucosa possessed practically no carbonic anhydrase activity; the extracts made from the mucosa of the pregnant uteri, however, invariably showed strong carbonic anhydrase activity which could be completely inhibited by low concentrations of sulphanilamide, the specific inhibitor of this enzyme⁶; the residual blood in the uterine extracts accounted for not more than a tenth to a twentieth of the total enzymic activity inherent in the mucous membrane.

It is too early to speculate on the mechanism of bicarbonate formation in the early blastocysts, and on the role of carbonic anhydrase in the pregnant uterus. However, by way of commentary, we should like to recall briefly certain facts which may well have some bearing upon our observations. Concerning first the presence of bicarbonate in the rapidly growing blastocysts, it is significant that the requirement for bicarbonate, and also for phosphate ions, in synthetic media for embryonic cells proliferating in tissue cultures has repeatedly been stressed of late^{6,7}. While, however, the inner cell mass of the rabbit blastocysts obviously has at its disposal an ample supply of bicarbonate, the total phosphorus content of whole six-day-old blastocysts was found to be not more than 2.5–2.8 mgm. per cent. Next, with reference to the occurrence of carbonic anhydrase in the female reproductive tract, it is noteworthy that some time ago its presence was reported⁸ in the uterine epithelium of egg-laying hens. Lastly, certain observations of Meldrum and Roughton⁹ may also be relevant to our findings; these authors have observed that early foetal goat blood contained but traces of carbonic anhydrase, and that even towards the end of gestation foetal blood still possessed only 10 per cent of the activity of maternal blood; furthermore, a similar deficiency in carbonic anhydrase is known to exist in chicken embryos¹⁰.

Efforts are being made to extend to other species the present study on the distribution of uterine carbonic anhydrase throughout the entire period of pregnancy, in an endeavour to establish the physiological significance of this enzyme for the developing embryo; it is hoped that at the same time a clue

may be found to account for the high content of bicarbonate in the early blastocysts.

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Ruminant-like Digestion in a Marsupial

WITH very few exceptions, animals do not produce an alimentary cellulase; consequently cellulose, which may constitute a considerable proportion of the diet of herbivores under many environmental conditions, is made available as a nutrient only by the fermentative activities of the microbial population of the alimentary tract. In most mammals this occurs in the oecum and colon, where the material is delayed long enough for effective fermentation. Their digestive physiology is nevertheless characterized by the absorption of glucose. This is the main metabolic fuel and is found in high concentration in the blood, a much reduced level resulting in coma.

The contrasting digestive physiology of ruminants has been extensively investigated in recent years. Ingested food passes directly to the rumen where a considerable quantity of the cellulose, as well as the other more soluble carbohydrates, undergoes fermentation resulting in a mixture of fatty acids¹ along with carbon dioxide and methane. Favourable growth conditions for the rumen microbial population are maintained by the copious alkaline salivary secretion. This pregastric fermentation means that little or no glucose-yielding materials are presented for absorption from the intestines. This is reflected in a much lower blood-glucose level in ruminants (35.5 mgm. per cent)² than in non-ruminants (80 mgm. per cent). Of the volatile fatty acids absorbed from the rumen and large intestines³, part are gluconeogenic, as most of the circulating acid is acetic acid, which has a glucose-sparing action in the tissues⁴. Consistent with this, very low blood-glucose levels after insulin treatment are well tolerated⁵.

The experiments on the macropod marsupial (*Sotorius brachyurus*) reported briefly here were initiated as a result of three unrelated observations: (a) dissections showed that the stomach was comparatively large, sacculated in the upper regions and possessed a well-defined oesophageal groove; (b) unconfirmed reports of cud-chewing in kangaroos; and (c) the finding, in connexion with studies of adrenal functions⁶, that the normal low blood-sugar could be lowered still further by insulin treatment without overt deleterious effect.

A ruminant-like digestion was thus suggested, and microscopical observation on stomach contents con-

firmed the presence of a rich microbial population similar to, but rather simpler than, that of the sheep. No ciliates have been observed; but this may be due to the diet. The digestibility of the cellulose has not been assessed, but extensive microbial erosion of this material within the stomach has been observed. The steam-volatile acids produced in the upper stomach are almost completely absorbed by the time the ingesta reaches the fundus. The pH of the upper stomach varies between 4.6, and 8.0, according to the activities of the micro-organisms and the level of fatty acids (range 15–2 M/mol. per cent). The identity of the volatile acids has not been investigated, nor the source of alkali to the upper stomach.

Blood drawn from the aorta, the vena cava, hepatic-portal vein and the hepatic vein confirm the relatively low blood-sugar status of the animal, and show clearly that the fatty acids produced in the stomach and caecum are absorbed into the portal vein. Some of these acids are removed in the liver, and comparison of arterial values and venous returns demonstrate clearly that fatty acid is removed by the tissues. These experiments will be reported fully elsewhere.

These findings are of interest on two counts. (1) It is generally held that the evolutionary lines emerging from therapsid reptiles and leading to marsupials and eutheria have been separate since the Cretaceous. This means that the ruminant type of digestion has been developed independently in marsupial macropods and eutherian ruminants. It is therefore a new and compelling example of parallel (or convergent) evolution. (2) *Setonix*, domesticated and averaging only 2–3 kgm., promises to be a cheap and fruitful tool for metabolic studies parallel to those on domestic ruminants.

The marsupial-holding pens were erected with funds from the Commonwealth Research Grants to the University; salary and expenses for G. Sharman were from a Nuffield grant.

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- ¹ Haden, S. B., Hitchcock, M. W. S., Marshall, R. A., and Phillips, A. T., *J. Exp. Biol.*, **22**, 191 (1946).
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Intravital Staining in Titrations of Group B Coxsackie Viruses in Weaned Mice

GROUP B Coxsackie viruses have been shown to be capable of producing a severe pancreatitis in weanling and adult mice¹. Necrosis of pancreatic acinar tissue occurs within a few days of infection and involves a high proportion of the cells in affected areas. These observations, together with the affinity of necrotic tissue for acid intravital dyes, have been utilized in the development of a technique for the rapid titration of pancreatotropic group B strains in weaned mice. Briefly, the technique is as follows.

The mice used in the titrations are injected intraperitoneally with 0.5 ml. of a 0.5 per cent solution

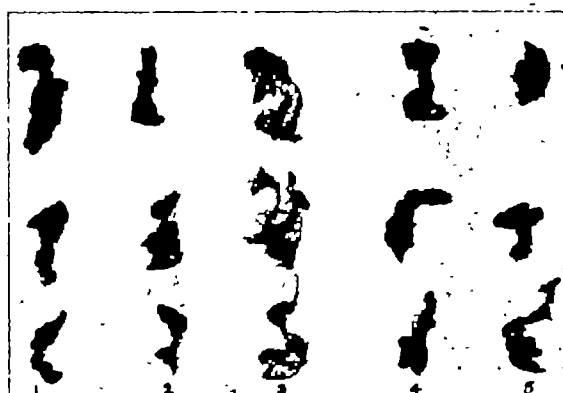


Fig. 1. Pancreatic staining in normal and infected mice. Infected pancreas stains deep blue, normal pancreas remains pink. 1 and 2, Connecticut 5; 3, normal; 4 and 5, Nancy

of trypan blue in saline, four days after inoculation with virus. When mice are killed four hours after injection with the dye, the pancreas in infected animals is found to be stained intensely (Fig. 1). In most cases intense dark blue staining of a large part of the pancreas is found, and in the remainder, lighter blue areas of varying size are seen. Staining may be demonstrated from two days after inoculation with virus, and increases rapidly in intensity. Maximum intensity of staining is reached within four days, and is retained for several days. These results were obtained by investigation of the influence of virus dosage and time on the degree of staining, and showed that the most suitable (shortest) time between inoculation with virus and injection with dye in titrations is four days.

In the accompanying table, results of five parallel titrations in mice 21–24 days old of a single pool of a Group B strain (Adelaide 1) by two methods are presented. The 'conventional' LD50 and ID50 titres were calculated by the method of Reed and Muench² from the number of deaths which occurred within three weeks and the number of survivors which had suffered fat replacement of pancreatic acinar tissue.

The titre determined by the intravital staining technique was found to agree closely with the LD50 titre; the 'conventional' ID50 titre was slightly higher. The latter observation suggests that, in a small proportion of infected mice, pancreatic necrosis is not revealed by intravital staining, either as a result of delayed development of the lesion when the inoculum is small, or because not all centres of necrosis involve the surface of the pancreas.

In further experiments the technique has been shown to be suitable for use in neutralization tests, since neutralization indices of sera estimated by the above technique and by LD50 estimations agreed closely.

COMPARISON OF TITRES OF A GROUP B VIRUS BY TWO TECHNIQUES

Titration number	Conventional technique		Intra-vital staining technique
	LD50	ID50	ID50
1	4.75*	5.22	4.63
2	5.17	5.50	5.37
3	4.96	5.17	4.67
4	5.06	5.24	5.37
5	4.33	4.33	4.75
Mean	5.02	5.23	5.00
Standard deviation	0.41	0.28	0.34

* Titres are expressed as their negative logarithms.

The techniques almost universally adopted for the titration of Coxsackie viruses, and for the detection of neutralizing antibodies against them, employ suckling mice inoculated within a few days of birth*. When suckling mice are used, non-specific deaths and cannibalism of sick mice are relatively common. In Group B infections with pancreatotropic strains, the main signs of infection (oedema, weakness and cyanosis) may also be seen in mice dying from non-specific causes. Also, maintenance of an adequate supply of litters may be difficult, particularly in small laboratories. The technique described overcomes many difficulties by allowing the use of weaned instead of suckling mice; by reducing the time taken in titrations from three weeks to four days—in itself desirable—accommodation problems are alleviated, and much of the time normally spent in the daily examination of mice is saved. The method would be particularly valuable in large-scale screening tests of sera for neutralizing antibodies, and is at present being used successfully in this laboratory for that purpose.

To date the technique has been successfully applied to three Group B strains, namely, Connecticut 5, Nancy, and Adelaide 1, representing three serological types. Although pathogenicity of Group B strains for weaned and adult mice has not been widely reported, Dalldorf⁴ has recently presented evidence that this may be due to differences in the methods used for virus passage rather than to differences in susceptibility of different mouse strains. The technique may therefore be more widely applicable than at first appeared possible. A more detailed account of this work will be published elsewhere.

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Chromosome Number of Human Endometrium

The determination of chromosome number in human somatic tissues has been the cause of controversy from time to time. Recently, Timonen¹ made an extensive study on the variations of the chromosome number in the human endometrium in the proliferative stage. From a study of one thousand nuclei, he finds that the highest frequency distribution is between 21 and 25 chromosomes. This result has been criticized by Sachs²; the number obtained by him from the same tissue of human beings and from other mammals corresponds to the diploid number of the particular species concerned.

For some time past, I have been studying the chromosome number in human endometrium and also in the epithelial cells of the cervix uteri both in normal and in malignant conditions. The present communication is based on the study of the chromosomes of the human endometrium in the proliferative stage.

Human endometrial tissue immediately after removal was cut into small pieces and was transferred to 0.002–0.005 M oxyquinoline solution³ for 2 hr. at 16°C., after which it was fixed either in acetic



Fig. 1. Metaphase chromosomes of human endometrium. ($\times 1,000$)

alcohol for Feulgen squash or was subjected to the aceto-carmine technique. As a result of the pre-treatment, the chromosomes are more or less straightened, and the centromeric region and the split between the chromatids of the individual chromosome are exaggerated (Fig. 1). Squashing may also cause cellular damage, as pointed out by Sachs². Doubtful cases have therefore been avoided so far as practicable.

The chromosome number counted in the different cells of my material varies from 30 to 59 chromosomes (Fig. 2). Of 75 nuclei counted, 15 had 48 chromosomes and 37 had chromosome numbers ranging from 40 to 47; of the latter, 33 nuclei had 40–45 chromosomes. Twenty nuclei had chromosomes ranging from 30 to 39, of which 14 had 36–39 chromosomes. Three nuclei had 54, 55 and 59 chromosomes respectively. My observations, therefore, support Timonen's conclusion regarding the variability of the chromosome numbers between different cells, but the range and characteristics of variation observed by him are not found in my material. My unpublished observations on the chromosome numbers in human uterine cervix tissue also support Timonen's conclusion regarding the variability of chromosome numbers in human somatic tissue.

Thus, it now appears fairly certain that the chromosome numbers vary widely between different cells of the same tissue as well as between different tissues, not only in human beings but also in other mammals. That this is due to the presence of mitotic abnormalities such as lagging, non-disjunction, multipolar spindle, etc., in the tissue is also clear. Admittedly, human tissue is difficult material for chromosome counts; but the differences in results reported by Timonen, Sachs and myself can scarcely be due to technique alone. There must be some other real source of variation which would account for the differences. It seems to me that two factors may play an important part in the production of a particular frequency distribution of chromosome

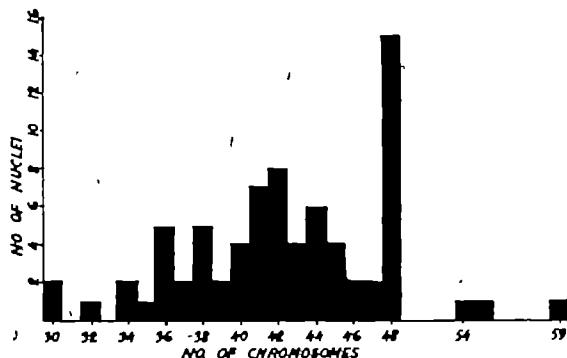


Fig. 2. Frequency distribution of chromosome numbers

number in a particular tissue. They are: (i) mitotic age of the tissue; and (ii) frequency of mitotic abnormalities originally present in the tissue. Gopal-Ayengar³ has reported a very significant observation which supports this hypothesis. He finds, in his study of transplanted tumours in several strains of mice and rats and in the Chinese and golden hamsters, that the cell population of early transplanted generations of tumours are almost entirely diploid, whereas later transplants have diploid, triploid and intermediate types exhibiting a gradual shift to tetraploidy.

I am indebted to Dr. Subodh Mitra, director of the Chittaranjan Cancer Hospital, Calcutta, for providing laboratory facilities and for his interest, and to Dr. S. P. Ray-Chaudhuri, of the University of Calcutta, for his guidance during the course of investigation.

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Physiology of the Heart of *Asellus aquaticus* L.

WORK on this subject was carried out some years ago, on nearly three hundred intact individuals and heart preparations, the latter consisting of heart, pericardium and dorsal body-wall of the thoracic region. The heart-rate of an average (10 mm.) individual at summer temperature was 180–200 per min., but heart-beat was interrupted for short periods, for example, at the onset of a burst of locomotor activity. Dissection of the preparation always slowed and sometimes arrested the beat for periods up to 30 min. On recovery, the beat was regular and incessant, often at the maximal normal rate.

Mechanical and electrical stimulation revealed an accelerator nerve following the anterior aorta, undoubtedly the anterior nerve of Alexandrowicz¹. Transection of the ventral nerve cord just behind the head regularly slowed the heart *in situ*. Transection of the anterior aorta in this region had little effect, and transection of the ventral nerve cord farther back had progressively less effect. Section of the anterior thoracic segmental nerves also had little effect; but cutting those of posterior segments, or damage to the abdominal ganglia, often (not always) caused temporary arrest—probably an injury-stimulation of cardio-inhibitory fibres.

Faradic stimulation of the preparation accelerated the beat, which synchronized with the stimulus at moderate rates of acceleration. Increasing rate progressively shortened systole, until complete diastolic 'amplitude-arrest'—probably tetanization of the dilator muscles². On switching off, such an arrested heart passed back through the stage of rapid flutter to its normal beat. Sensitivity of the heart to faradic stimulation when applied in the aortic region was greater than when applied in the heart region itself, so that a rate of stimulation which arrested when applied in the former region, accelerated when applied in the latter. Sensitivity was much lower to faradic currents applied transversely than to those along the heart.

Relatively light pressure, localized or diffuse, to the ventral face of the floor of the pericardium caused arrest, its duration proportional to intensity of stimulation; a local reflex inhibition seems indicated. Moderate traction dorsalwards of the roof of the pericardium (that is, the body-wall) usually accelerated the heart-rate, and the volume of the pericardium may be the critical factor. Excessive traction inhibited heart-beat.

Asynchrony between the two ends of the heart was observed after transection of the dorsal heart-wall³, and often in moribund preparations. Sometimes asynchrony between the lateral halves was observed; on occasion one half, longitudinal or lateral, was completely quiescent. Complete asynchrony of all muscle fibres—the 'bag of worms' type of fibrillation—was produced by excess sodium chloride and possibly by other conditions. Activity of aortic valves and ostia showed some independence of that of the myocardium, as expected from their innervation¹; but in recovery from arrest, activity often began in the ostia and spread to the myocardium.

The optimal concentration of sodium chloride for survival appeared to be 0.6 per cent, that is, lower than that used by Kawaguti⁴ for *A. nipponensis*. Preparations survived up to 48 hours in 0.6 per cent sodium chloride, 0.02 per cent potassium chloride, 0.02 per cent calcium chloride, 0.02 per cent sodium bicarbonate, and 0.2 per cent glucose. Excess calcium and deficit of potassium ions slowed or arrested the heart in diastole. Excess potassium ions accelerated, with diastolic amplitude-arrest as the limit; exoskeletal calcium ions probably prevented effective calcium-deficit, and calcium-free Ringer's solution had little effect. Magnesium, beryllium and hydrogen ions slowed, to arrest in diastole. Acetyl-choline accelerated in relatively high concentration⁵. Adrenalin had no consistent effect. Inhibition by the animal's own digestive fluid⁶ was confirmed; mammalian lipase and trypsin similarly inhibited.

The curve relating temperature centigrade (T) (changed gradually) to beat-interval (t), that is, to the reciprocal of rate, was approximately a rectangular hyperbola $(t + a)(T + b) = c$, where a , b , c are constants. Thus there was an upper limiting rate and a lower limiting temperature, a 'physiological zero', at which the beat virtually ceased. This varied between $+4^\circ$ and -4° C. (obtained by supercooling), in different individuals, but was usually below 0° C. Maximal rate was attained at 25 – 35° C., that is, again variable between individuals; above this temperature there were irregularities and slowing of the beat. Since a was small (less than 0.5 sec.) a virtually linear relationship between rate and T was often obtained, and it follows also that $(\log t)/(\log (T + b))$ was virtually linear. Preparations frozen by seeding the supercooled medium recovered their beat on thawing.

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¹ Alexandrowicz, J. S., *J. Mar. Biol. Assoc. U.K.*, 31, 85 (1952).

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FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Monday, February 8

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Lord Rennell of Rodd: "Aids to the Domesday Geography of N.W. Hereford".

UNIVERSITY OF LONDON (at the Imperial College of Science and Technology, Royal School of Mines, Prince Consort Road, London, S.W.7), at 6 p.m.—Prof. A. Kantrowitz (Cornell): "Physics of Shock Waves".* (Further Lectures on February 9, 22 and 23.)

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (In the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. F. B. Kemmer: "The Domestication of Animals by Early Man: Its Psychological and Social Aspects".

UNIVERSITY OF LONDON (In the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. C. Schmegeot (Paris): "The Metabolism of Sulphur Amino-Acids and the Oxide of Sulphur in Nature".* (Further Lectures on February 11 and 16.)

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (Joint meeting with the AGROCHEMICAL GROUP, at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Dr. B. M. Crowther: "The Protection and Use of Fertilisers—Some Current Trends and Problems" (Bible Memorial Lecture).

Tuesday, February 9

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. Lord Stamp: "The Action of Bacterial Enzymes on Immunizing Antigens".* (Eight of fifteen Lectures on "The Scientific Basis of Medicine".)

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. R. P. Inglis: "Non-Ferrous Metals for the Chemical Engineer".

PRESENTATION OF TECHNICAL INFORMATION DISCUSSION GROUP (In the Mechanical Lecture Theatre, Department of Electrical Engineering, University College London, Gower Street, London, W.C.1), at 1 p.m.—Mr. J. Kennedy: "The Making of a Book—The Author and his Printer".

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

Wednesday, February 10

SOCIETY OF CHEMICAL INDUSTRY, FOOD AND MICROBIOLOGY GROUPS (at the Low Temperature Research Station, Downing Street, Cambridge), at 2.15 p.m.—Symposium on "The Preservation of Food with ionizing Radiations".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Dr. J. A. Saxton: "Radio Ground-Wave Propagation Characteristics in the 50-800 Mc./s. band". Dr. J. A. Saxton and Mr. B. N. Harden: "Ground-Wave Field Strength Surveys at 100 and 600 Mc./s".

TELEVISION SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Mr. G. G. Gourlet: "Colour Television: The Fleming Memorial Lecture, Part 1". (Further Lecture on February 24.)

RADAR ASSOCIATION (In the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 7.30 p.m.—Mr. K. E. Harris: "Some Unsolved Radar Problems".

Thursday, February 11

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "Heat Treatment of Milk within the Bottle", opened by Prof. H. L. Crossley.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 8.00 p.m.—Mr. R. D. Keynes: "The Ionic Fluxes in Frog Muscle"; R. G. S. Christie and Mr. J. D. Judah: "Mechanism of Action of carbon Tetrachloride on Liver Cells".

BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. H. B. Maitland: "Anti-Virus Immunity".* (Ninth of fifteen Lectures on "The Scientific Basis of Medicine".)

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, London, S.W.1), at 6 p.m.—Dr. D. Williams: "Recent Developments in the Structural Approach to Aeroblastic problems".

UNIVERSITY OF LONDON (at Wye College, near Ashford, Kent), at 15 p.m.—Mr. H. M. Nicholson: "The Nature Conservancy".*

Friday, February 12

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Anniversary Meeting; Annual General Meeting.

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Third Report of the Pe Flanges Research Committee, presented by Dr. A. B. Johnson.

ARLIS (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr. C. W. Hanson and Mr. C. H. O. Swenson: "Journal Circulation: An Enquiry into the Practice".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. Keith Simpson: "Science in Crime Detection".

Saturday, February 13

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (Joint meeting with the ASSOCIATION OF CHEMICAL BIOCHEMISTS, S.H. and S.W. REASON, in the Department of Zoology, The University, Reading), at 2.30 p.m.—Papers and Demonstrations on "Physical Methods in Biochemistry".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree in chemistry or a biological subject, or approved equivalent professional qualifications, and at least three years postgraduate or other approved experience), and an EXPERIMENTAL OFFICER (with a degree in an approved scientific subject, or equivalent professional qualifications), in the Combined Scientific Development and Forensic Science Department of the Ministry of Commerce—The Secretary, Civil Service Commission, Stormont, Belfast (February 12).

SENIOR TECHNICIAN (with knowledge of E.H.T. and pulse circuits for Geiger and scintillation counting) for maintenance and development of electronic equipment—The Secretary, Board of Governors, Hammar-smith Hospital and Postgraduate Medical School, Du Cane Road, London, W.12 (February 13).

LECTURER (with qualifications in cytology, genetics and plant breeding, and with teaching and research experience in these subjects) in BOTANY—The Secretary, The University, Aberdeen (February 15).

LECTURER (with a degree or a recognized diploma in mining) in the DEPARTMENT OF MINING AND GEOLOGY, and a LECTURER (with an honours degree in physics, and preferably with teaching, industrial, or research experience) in PHYSICS—The Principal, Wigan and District Mining and Technical College, Wigan (February 15).

ASSISTANT LECTURER in the DEPARTMENT OF CHEMISTRY, and an ASSISTANT LECTURER in the DEPARTMENT OF PHYSICS—The Secretary, Bedford College, Regent's Park, London, N.W.1 (February 19).

SENIOR PHYSICIST (with an honours degree in physics, and five years previous experience in hospital physics or research, and preferably with a practical knowledge of radio-elements)—The Secretary, Lambeth Group Hospital Management Committee, Renfrew Road, London, S.E.11 (February 19).

ASSISTANT LECTURER (with special qualifications in physical chemistry or in physical organic chemistry) in the DEPARTMENT OF CHEMISTRY—The Registrar, University College of South Wales and Monmouth, Cathays Park, Cardiff (February 20).

ASSISTANT LECTURER in CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (February 27).

CHIEF CHAIR OF METALLURGY—The Registrar, The University, Nottingham (March 1).

PROFESSOR OF PHYSIOLOGY at the University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, March 1).

UNIVERSITY DEMONSTRATOR in AGRICULTURAL ZOOLOGY AND PHYSIOLOGY OF FARM ANIMALS, a UNIVERSITY DEMONSTRATOR in SOIL SCIENCE, a UNIVERSITY LECTURER in AGRICULTURAL ZOOLOGY AND PHYSIOLOGY OF FARM ANIMALS, and a UNIVERSITY DEMONSTRATOR in AGRICULTURAL BOTANY—The Secretary, School of Agriculture, Downing Street, Cambridge (March 6).

ASSISTANT LECTURER in PHYSICS, and an ASSISTANT LECTURER in THEORETICAL PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (March 6).

CHAIR OF GEOGRAPHY—The Registrar, University College, Leicester (March 6).

LECTURER in CHEMISTRY, a DEMONSTRATOR in BIOCHEMISTRY, and a DEMONSTRATOR in CHEMISTRY, in the Department of Biochemistry and Chemistry—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (March 6).

LECTURER (with an honours degree in mechanical engineering, and special experience of mechanical engineering drawing and design theory of machines and strength of materials) in MECHANICAL ENGINEERING, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, March 7).

LECTURER in PHILOSOPHY at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Johannesburg, March 31).

I.C.I. RESEARCH FELLOWSHIPS in PHYSICS, CHEMISTRY, BIOCHEMISTRY, ENGINEERING, METALLURGY, PHARMACOLOGY, CHEMOTHERAPY, or related subjects—The Secretary General of the Facilities, The Old School, Cambridge (April 30).

TURNER AND NEWALL RESEARCH FELLOWSHIPS for research in ENGINEERING, INORGANIC CHEMISTRY, PHYSICS, and allied subjects—The Registrar, The University, Manchester 13 (April 30).

JUNIOR LECTURER in the DEPARTMENT OF ENTOMOLOGY—The Assistant Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1 (June 1).

AGRICULTURAL OFFICER (with a degree or diploma in agriculture or allied subjects), at Dunholme Field Station, near Lincoln, for duties which will include organizing field experiments, and assisting with research work on sugar beet—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

CHAIR OF EDUCATION—The Registrar, The University, Sheffield.
DIRECTOR OF THE BHARAT SAHNI INSTITUTE OF PALAEBOTANY, to take charge of the administration of the Institute, and to conduct and supervise research—The President, Governing Body of the Palaeobotanical Society, Bharat Sahni Institute of Palaeobotany, Lucknow, U.P., India.

EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (with at least higher national certificate or equivalent and a thorough knowledge of basic radio and electronics) in the TIME DEPARTMENT, Royal Greenwich Observatory, Abingdon, for maintenance and installation of operational equipment of time service.—The Ministry of Labour and National Service, Technical and Scientific Register (R), 20 King Street, London, S.W.1, quoting D.9/54A.

GEOLGISTS (with first- or good second-class honours degree in geology) in Malaya, for investigations of mineral resources and detailed geological mapping.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODH.106/60/03.

MICROBIOLOGIST (with a first- or good second-class honours degree in an appropriate subject, and with at least two years postgraduate experience in soil microbiology) in the East African Agricultural and Forestry Research Organization, to take charge of new Soil Microbiological Section.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODH.87/53/02.

PHYSICIST or ELECTRICAL ENGINEER (with at least H.S.C. (science), or equivalent, and preferably with experience of experimental work using electronic equipment), at the Ministry of Supply Radar Research Establishment, Malvern, to work on problems of packaging of electronic equipment, involving investigation of cushioning systems under simulated service hazards, and design of shock suspension systems for items of radar equipment having special packaging problems.—The Ministry of Labour and National Service, Technical and Scientific Register (R), 20 King Street, London, S.W.1, quoting A.8/54A.

PHYSICIST (with an honours degree in physics), to carry out fundamental investigations connected with new methods of casting steel by continuous processes.—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Casting".

PHYSICIST (with mathematical leanings) for experimental work on fibre assemblies.—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

PROFESSOR OF PHYSICS at the College of Arts and Science, Baghdad.—The Cultural Attaché, Iraqi Embassy, 29 Queens Gate, London, S.W.7.

SENIOR LECTURER in CHEMICAL ENGINEERING at the Technical College, Bradford.—The Director of Education, Town Hall, Bradford.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Bulletin of the British Museum (Natural History). Geology. Vol. 2. No. 3: The Solution of the Polden Problem. By J. B. Weimer, K. P. Oakley and W. H. Le Gros Clark. Pp. 150-146+plates 8 and 9. 2s. 6d. Mineralogy. Vol. 1. No. 4: Carbonates of the Chifwa Series of Southern Nyasaland. By W. Campbell Smith. Pp. 95-130+plate 7. 2s. (London: British Museum (Natural History), 1953.) [2411]

Papilloma of the Bladder in the Chemical Industry: a Study of its cause and prevention. Pp. v+18. (London: Association of British Chemical Manufacturers, 1953.) [2511]

Bulletin of the British Museum (Natural History). Entomology. Vol. 3. No. 2: A Revision of the Genus *Triclistus* Kirby (Lepidoptera: Lycaenidae). By H. Stempffer and N. H. Bennett. Pp. 77-104+plates 3-9. (London: British Museum (Natural History), 1953.) 7s. 6d. [2511]

Air Ministry: Meteorological Office. British Rainfall 1951. (The Ninety-Fifth Annual Volume of the British Rainfall Organization.) Report on the Distribution of Rain in Space and Time over Great Britain and Northern Ireland during the Year 1951 as recorded by about 6,000 Observers. Pp. iv+208. (London: H.M. Stationery Office, 1953.) 25s. net. [2511]

Council for the Preservation of Rural Wales. Annual Report 1952-53. Pp. 87-4 plates. (London: Council for the Preservation of Rural Wales, 1953.) [2511]

Ministry of Supply: Atomic Energy Research Establishment. Liquid-Liquid Extraction: a Critical Survey of the Literature dealing with the Mechanism of Transfer of Solutes Across Phase Boundaries, with Special Reference to Liquid-Liquid Interfaces. By J. B. Lewis. Pp. ii+23. (London: H.M. Stationery Office, 1953.) 2s. 6d. net. [2511]

City of Leicester Museums and Art Gallery. 47th Report to the City Council, 1st April, 1953, to 31st March, 1953. Pp. 44+4 plates. (Leicester: City of Leicester Museums and Art Gallery, 1953.) [3011]

Bulletin of the British Museum (Natural History). Geology. Vol. 2. No. 2: A Coniferous Petrified Forest in Patagonia. By Mary Gordon Calder. Pp. 97-138+plates 1-7. (London: British Museum (Natural History), 1953.) 12s. [3011]

Pitt Rivers Museum: University of Oxford. Stone-Worker's Progress: a Study of Stone Implements in the Pitt Rivers Museum. By Sir Francis H. S. Knowles, Bart. (Occasional Papers on Technology, 6.) Pp. 120. (Oxford: Pitt Rivers Museum, 1953.) [3011]

Slits and Morale: a Preliminary Study of Attendance at Work in Large and Small Units. Pp. 44. (London: The Action Society Trust, 1953.) 3s. 6d. [3011]

Department of Agriculture: Fisheries Branch. Report on the Sea and Inland Fisheries for the Year 1952, incorporating Statistics of the Capture of Salmon, Sea Trout and Hake. Pp. 52. (Pr. 1948.) (Dublin: Stationery Office, 1953.) 2s. 6d. [3011]

Committee on Air Pollution. Interim Report. Pp. 31. (Cmd. 9011.) (London: H.M. Stationery Office, 1953.) 1s. 6d. net. [4118]

Proceedings of the University of Durham Philosophical Society. Title Page and Index. Vol. 10 (1952-1950). Pp. 6. Vol. 11. No. 9: An Electrostatically Maintained Tuning Fork. By Dr. E. G. Richardson and Dr. Y. L. Yousef. Pp. 119-124. (Durham: University of Durham Philosophical Society, 1953.) [4118]

University Interchange between the United Kingdom and Other European Countries, 1948-1953. A Report on Reciprocal Schemes which are in Operation between the United Kingdom and Other Countries in Europe for the Promotion of Interchange Visits by Univer-

sity Teachers and for the Award of Scholarships. Pp. 24. (London: The British Council, 1953.) [4118]

Other Countries

U.S. Department of Agriculture. Leaflet No. 183: Oakworms. Pp. 8. (Washington: Government Printing Office, 1953.) [2411]

Reports of the Forest Research Institute of Sweden. Vol. 42 (1952-53). Pp. 430. (Stockholm: Centralkyrkostens, Huset AB, 1953.) 20 kronor. [2411]

Institut des Parcs Nationaux du Congo Belge. Exploration du Parc National Albert. (Deuxième série.) Fascicule 1: Les Stades de Récession du Glacier Stanley Occidental (Ruwenzori, Congo Belge). Pp. 25+8 plates. (Bruxelles: Institut des Parcs Nationaux du Congo Belge, 1953.) [2411]

Chemistry and Chemical Engineering at the California Institute of Technology, 1952-53. (A Report for the Academic Year on Research and other Activities of the Division of Chemistry and Chemical Engineering.) Pp. iv+121. (Pasadena: California Institute of Technology, 1953.) [2411]

Kungl. Svenska Vetenskapsakademien. Handlingar. Fjerd. Serien. Band 4. No. 2: Zur Technik der Gaswechselbestimmung. Von Hbba Ringhoff und Henrik Ringhoff. Pp. 29. 4.50 kronor. Band 4. No. 3: Isothermal transformation of austenites and partitioning of alloying elements in low alloy steels. By Axel Hultgren and collaborators. Pp. 47+11 plates. 9 kronor. Band 4. No. 6: Lattice Effects and Colour-Equivalents as Measured in Short R. Spectra. 3: Summary of classification criteria. Investigation of region of the open cluster in Coma Berenices. By Bengt Westberg. Pp. 50. 7.50 kronor. (Stockholm: Almqvist and Wiknell Bok- och AB, London: H. K. Lewis and Co., Ltd., 1953.) [2411]

Companhia de Diamantes de Angola. Museu do Dundo. Subsidio para a História, Arqueologia e Etnografia dos Povos da Lunda. Publicações Culturais No. 20: The Kalahari Sands of the Lunda (N. Angola), their Barlier Redistributions and the Sangoan Culture. J. J. Janmar. Pp. 65. (Lisboa: Companhia de Diamantes de Angola, 1953.) [2411]

United States: Department of the Interior. Geological Survey. Professional Paper 243-A: Ostracodes from the Upper part of the Sundance Formation of South Dakota, Wyoming and Southern Montana. By Frederick M. Swain and James A. Peterson. Pp. 17+3 plates. 25 cents. Professional Paper 243-B: Mica Deposits of the Southeastern Piedmont. Part 2: Amelia District, Virginia. By Richard M. Leake, Richard H. Johns and Wallace R. Griffin. Pp. iv+103-140. 60 cents. Professional Paper 243-D: Mica Deposits of the Southeastern Piedmont. Part 5: Shelby-Hickory District, North Carolina. Part 6: Outlying Deposits in North Carolina. By Wallace R. Griffin and Jerry O. Olson. Pp. v+203-294. n.p. Professional Paper 243-F: Mica Deposits of the Southeastern Piedmont. Part 9: Thomaston-Barnesville District, Georgia. Part 10: Outlying Deposits in Georgia. By W. Wm. Heinrich, Morris B. Klepper and Richard H. Johns. Pp. v+337-400. 1.50 dollars. (Washington, D.C.: Government Printing Office, 1952 and 1953.) [2411]

U.S. Department of Agriculture. Farmers' Bulletin No. 1627: The Hessian Fly, and how losses from it can be avoided. By W. B. Carywright and R. T. Jones. Pp. 9. 10 cents. Leaflet No. 241: The Meadow Spittlebug: How to Control It. Pp. 4. 5 cents. (Washington, D.C.: Government Printing Office, 1953.) [2511]

Abaque d'extraction de raoules et d'élevation aux puissances d'un nombre quelconque. Par Louis Lefroid. (Paris: Gauthier-Villars, 1953.) 600 francs. [2511]

Symposium on Strept. (Sponsored jointly by Division of Medical Sciences, National Research Council, and the Army Medical Service Graduate School, Walter Reed Army Medical Center. 16-18 May 1953, Army Medical Service Graduate School, Washington, D.C. Pp. ix+352. (Washington, D.C.: Government Printing Office, 1953.) [3011]

Army Medical Service Graduate School, Walter Reed Army Medical Center. Medical Science Publication 2: Acute Infectious Hemorrhagic Fevers and Myxomatosis in the Union of Soviet Socialist Republics. By D. Carleton Gajdusek. Pp. vii+140. (Washington, D.C.: Government Printing Office, 1953.) 60 cents. [3011]

University of Natal, Pietermaritzburg. South Africa. Wattle Research Institute (South African Wattle Growers' Union—University of Natal—Union Department of Forestry). Report for 1952-1953 (Sixth Year). Pp. 56+2 plates. (Pietermaritzburg: University of Natal, 1953.) [3011]

Seventh Pacific Science Congress, Vol. 5, 1953. An Outline on New Zealand Peat Deposits, with Notes on the Condition of the Rain-Forest on the Bogs. By Lucy M. Cranwell (Mrs. Watson Smith). Pp. 2. (Wellington, N.Z.: Government Printer, 1953.) [3011]

New Zealand. Twenty-seventh Annual Report of the Department of Scientific and Industrial Research. Pp. 108. (Wellington, N.Z.: Government Printer, 1953.) [3011]

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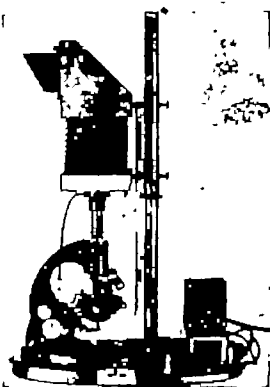
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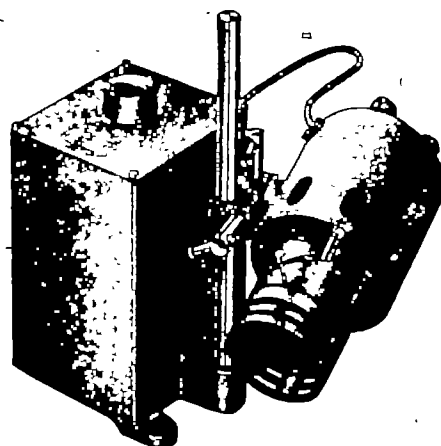
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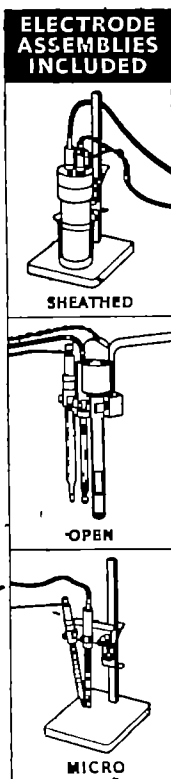
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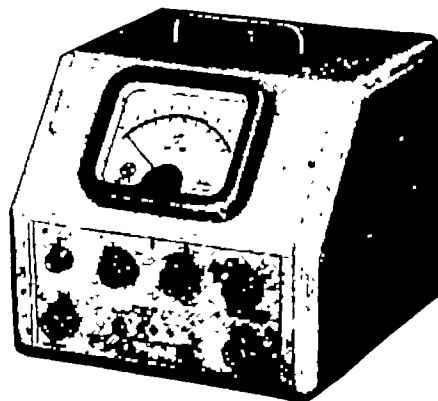


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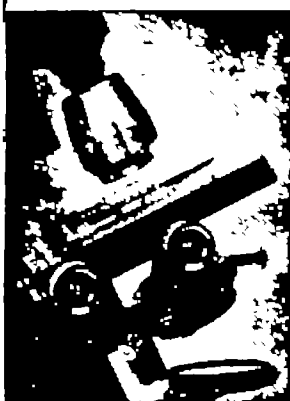
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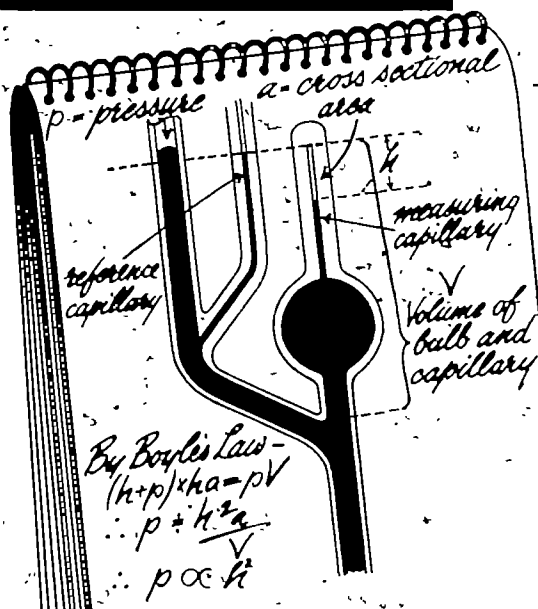
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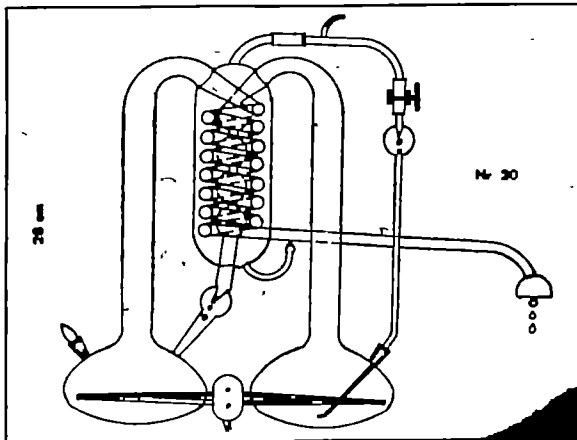
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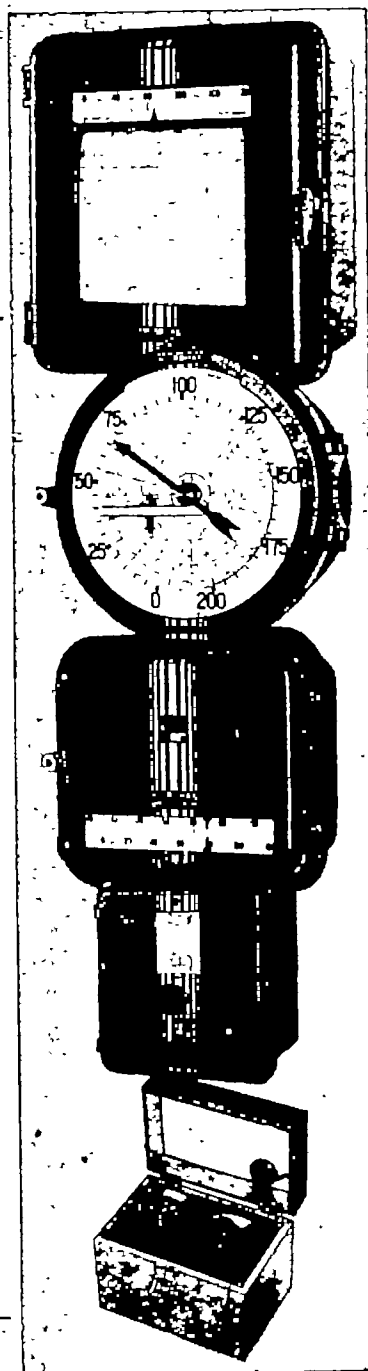
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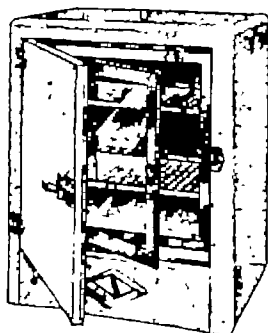
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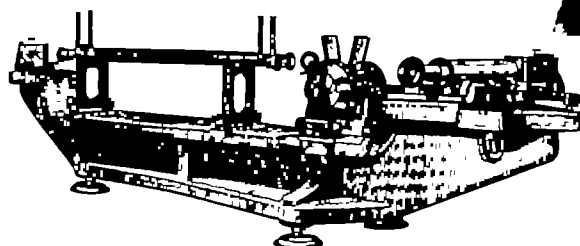
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AGE-LIMITS AND WORKING LIFE

THE National Advisory Committee on the Employment of Older Men and Women was appointed in March 1952, "to advise and assist the Minister of Labour and National Service in promoting the employment of older men and women". Under the chairmanship of Mr. H. Watkinson, Parliamentary Secretary to the Ministry of Labour and National Service, the Committee has taken this as an instruction to consider what conditions or circumstances hinder the employment of older persons and what are most likely to help. Its aim is to suggest the general lines on which the Government and public and private bodies may work together to enable and encourage men and women in all kinds of employment to use their skills and experience to a greater age, with benefit both to their own well-being and to the national economy.

The Committee's first report*, which has just been issued, shows that it is fully alive to the two main trends in Great Britain which give the employment of older men and women its present national importance—the changing age-structure of the population and the greater expectancy of life—and to the repercussions on personal life and on the national economy which are involved. Both considerations are kept in mind throughout this report; but, although since the Committee was appointed there has been a certain amount of piecemeal action to encourage the elderly to remain longer at work—some, but not all, of which is mentioned in the report—the Committee is wise in this first report to attempt to set forth the main considerations which require general discussion. It is convinced that the principal barrier to the extended employment of older persons lies in traditional attitudes of mind, which only a clearer understanding of the issues is likely to change.

The able statement of the national problem, which embraces consideration of economic and financial aspects beyond the scope of the Watkinson Committee and coming within the terms of reference of the Committee appointed by the Chancellor of the Exchequer "to review such problems in relation to provision for old age", with which Committee the Watkinson Committee expects to work in close co-operation, is an excellent contribution to that end. Its analysis of the changing age-structure and of the implications of working capacity in a longer life supplements admirably the lecture which Sir Frederic Bartlett gave two years ago (see *Nature*, 171, 623; 1953), and the Committee's brief remarks on present and future man-power needs have since received strong support in an address which Sir Godfrey Ince, Permanent Secretary to the Ministry of Labour and National Service, delivered to the Manchester Statistical Society on November 11. The Committee points out that, whereas in 1911 one in fifteen of the population of Great Britain was a man of sixty-five and more or a woman of sixty and more, in 1951 the proportion had doubled, and in 1977 it is estimated

* National Advisory Committee on the Employment of Older Men and Women. First Report. Pp. 62. (Omd. 8965.) (London: H.M. Stationery Office, 1953.) 2s. net.

as likely to be nearly three in fifteen. Of the 1951 total, two million were men aged 65-69 inclusive, or women aged 60-64. Moreover, the proportion of older people in the working population is also rising. Between 1952 and 1962 the population between the ages of twenty and forty is expected to decrease by about 7 per cent, and that between 50 and 60 to increase by about 17 per cent. By 1982, men aged 18-40 inclusive will be nearly 300,000 fewer than in 1952, and since on men in this age group the armed forces, the police, the fire services and all the occupations for which full vigour and activity are essential must have first claim, other occupations must employ a smaller proportion of them.

On this ground alone it is essential for all employers to make the fullest use of the abilities of older people below pensionable age, and also to employ to the best advantage those beyond pensionable age who are both able and willing to continue at work. Economic considerations enforce the argument. The increase in the proportion of older persons in the population means an increase in the amount of current production required for their maintenance; and the effect on standards of living may be greater should this increase not be offset both by advances in productivity and technical development and by the fullest possible utilization of the services of those able and willing to continue to be productive. No reliable estimate is as yet available of the numbers in Great Britain who might be available if they had the opportunity: at present some 400,000 men out of 850,000 in the 65-69 age group and 250,000 out of 1,250,000 in the over-70 age group are continuing at work, and the Ministry of Pensions and National Insurance is conducting a comprehensive inquiry on the Committee's behalf into the reasons influencing the individual's decision to retire or not; this should assist later in arriving at a reasonable approximation.

The Committee recognizes the need for more research into the process of ageing, and into the differing skills and abilities demanded by particular occupations; but its report adds little to what Sir Frederic Bartlett said on this point. Its argument, however, is strongly supported by evidence provided in the latest report from the Chief Inspector of Factories, in which Sir George Barnett emphasized that while the consequences of accidents to older people tend to be more serious, they do not appear to be more prone to accidents. Many are apparently able to exercise in industry the skill acquired in a life-time unaffected by advancing years. Here, again, more precise information is required before positive conclusions can be reached.

It is the Committee's observation that the encouragement of the employment of older people is a present as well as a long-term need which was most strongly endorsed by Sir Godfrey Ince. If it is Government policy to maintain a high and stable level of employment for all who want to work and are fit to do so, the Committee is convinced there should be no age limit. Limitation of employment opportunities for older people who want to work is not a tolerable permanent solution for unemployment either from a human or an economic point of

view. From the short-term point of view Sir Godfrey shows that it may be disastrous.

Assuming during the next ten years a decline of only six per cent in the working population aged between twenty and forty, and an increase of 20 per cent in those aged between fifty and sixty, Sir Godfrey pointed out that the small rise in the total working population expected over the next eight years would by no means match the necessary rate of increase in production. Analysis of the four main tasks now before Great Britain, he said, shows that no immediate substantial reduction can be forecast in the demands of the defence programme: we are unlikely, therefore, to have additional man-power available to expand the capital investment programme and increase the export of engineering products. The second task is the maintenance of exports at an increasingly high level, the third to maintain home capital expenditure at a much higher level than at present and the fourth to produce sufficient consumer goods to keep up the country's standard of living.

These formidable and essential tasks can only be carried out, said Sir Godfrey, apart from some unforeseen change in the general economic situation, by increasing production and particularly by the more efficient use of man-power. Apart from the modernization, improvement and extension of plant, machinery and mechanical power, this will involve the distribution of man-power so that the maximum number of workers are in the right jobs, in the right districts at the right time, more careful training of recruits and existing workers and the establishment of good human relationships in industry. Even so, it is probable that the Armed Forces will have considerable difficulty in recruiting the man-power they need.

The corollary of Sir Godfrey Ince's address is clear: not merely must there be more mobility of labour and the general abandonment of restrictive practices and national habits on the part of industry and business, including the trade unions; there must also be much more flexibility and fresh thinking about retirement, production and employment generally. A new attitude may be required in which the approach is expressed not by 'no men over forty need apply', but rather 'no man under forty need apply'. There are manifestly jobs in industry and commerce in the broadest sense in which the employment of fit men under forty is a disservice to the State.

The Watkinson Committee's observations on engagement and retirement policy, on professional, managerial and executive employment, and on pension schemes, and its tentative recommendations should be considered in the light of such a change of outlook. The Committee insists that the test for engagement should be capacity and not age, and urges that retirement policy should be such that all men and women employed in industry, commerce, the professions and elsewhere, who can give effective service, either in their normal work or in any alternative work which their employers can make available, should be given the opportunity, without regard to age, to continue at work if they so wish. The main difficulties in

giving effect to these principles are found among the professional, managerial and executive classes; but it is here that the Committee believes that unnecessary waste of ability, qualifications and experience is most likely. Moreover, the shortening of the span of working life of the professional classes and certain others in the higher ranges of employment in this century, due to the lengthening of professional training and to earlier retirement on pension, represents a real loss of public and private investment.

The Committee does not underrate the difficulties, but it rightly urges that there should be more flexibility in regard to salary scales, promotion systems and superannuation schemes. The difficulties are a challenge to personnel management which some organizations have already met. What is required is a fresh approach to the question of the retiring age, which may avoid invidious decisions, and still more a greater readiness to make exceptions to it where desirable—and these exceptions should be frequent. Moreover, since pension schemes have a greater influence on the opportunities for employment among the professional and executive class than elsewhere, the modification of such schemes is a matter which concerns not merely professional workers and their own associations as well as their employers, whether industry, the Government or the universities or other bodies, but also the insurance companies with which pension schemes may be arranged. If insurance companies undertaking such business made a common fund and invited those concerns which carry their own funds to join and agree on two or three alternative forms of superannuation contract as standard, it would be easier to provide the flexibility desirable. Moreover, there would be the further important advantage that by enabling a policy holder to move from one concern to another without wasting his own or the employers' contributions, not only would it be easier to place the elderly worker in a suitable post but also throughout his career mobility would be encouraged, to the great advantage of the country as a whole.

There is need both for more information and for more thought on all these matters, as the Committee recognizes. Reference is made to some examples of changes in practice in the recruitment of older workers and in retirement policy, both in industry and in government and local government service. The Minister of Health has since pointed out that between January 1, 1952, and July 1, 1953, the number of permanent Civil servants over sixty years of age increased from 18,781 to 29,208, although there has been a simultaneous decrease of 25,460 in the size of the Civil Service. The Life Offices Association has since issued a statement indicating three ways of designing pension schemes which should eliminate employers' objections, on superannuation grounds, to employing older men. In the University of Oxford, motions to raise the retiring age of all teaching and administrative staff were approved by Congregation on November 3, and on the same day a debate at a meeting of the Senate of the University of Cambridge on a report from the Council on the question of retirement indicated that, while there were diverse

views on the question of retiring age, the importance of making greater use of the services of retired officers or teachers was fully appreciated.

The Watkinson Committee deprecates any attempt to move too fast. This first report is intended rather to provoke discussion and to stimulate thought about the various difficulties which questions of promotion and pension schemes present; and to encourage the initiation of further inquiries into fitness and capacity for work at later ages, into the productivity of older workers in comparison with that of younger workers on various types of work, into absenteeism and time-keeping and accident-rates, into the desirability of change of occupation—perhaps with re-training in middle or later life—for men and women employed in certain jobs which may be less suitable for older workers, and into the possibility of minor adjustments in methods and conditions of work and in the design of machinery, which should be advantageous to all, but particularly to the older workers. Some such inquiries the Committee itself proposes to institute, though it will need the co-operation of research bodies and of industry. Meanwhile, this preliminary review should encourage the introduction of further experimental schemes in business and industry, and the careful discussion of the whole subject by employers, trade unions, professional associations and others concerned, above all in the light of the implication of Sir Godfrey Ince's address that we can no longer afford to assign able-bodied men to light jobs which could be performed quite as well by men past their prime.

Where the scientist and technologist are concerned, the demographic argument is strongly reinforced by the existing shortage of scientific manpower. Although the Advisory Council on Scientific Policy in its last annual report stressed the need for greater use of scientists and technologists in industry, and this has been repeatedly urged in diverse quarters and in discussions on higher technological education, no further appreciation of the situation as a whole has appeared since the report of Prof. S. Zuckerman's Standing Committee on Scientific Manpower was submitted by the Advisory Council as its own fifth report. No indication has been given regarding any action on the Zuckerman Committee's suggestions, though the position as regards science teachers appears to have deteriorated. A Productivity Team's report on the heavy chemical industry, which indicated that the ratio of technicians to operatives on the pay-roll is one to six in the United States compared with one to sixteen in Great Britain, tends to support the general impression that, on the whole, British industry does not make anything like sufficient use of trained scientific and technical man-power. Moreover, Sir Ewart Smith's outburst at the annual conference of the British Institute of Management carried the implication that not only is industry using too few highly trained engineering technologists, but also that we are not using as wisely as we might the scientific and technical man-power at our disposal.

The most efficient use of scientific man-power was considered eight years ago by the Barlow Committee on scientific staff, but its recommendations have lost

none of their force in the interval, either in Government departments, in industry or in the universities. The wise use of man-power is above all a matter for management, and it is on management that the major share of responsibility must fall for the adjustments which will ease the strain on our limited resources of man-power as the demographic trends have full effect. Of others also, in the trade unions and in professional associations, a new outlook will be demanded and a readiness to shed obsolete practices and old habits and ideas: the task is not simply one of finding and training men of the requisite ability as managers; but wise management can do something to assist those changes and processes of adjustment. The Watkinson's Committee report is a timely reminder that some hard and constructive thinking is required fairly generally in the professions, in industry, in Government departments and public corporations and in the universities; the report is likewise a useful contribution to the task of education. Last, but not least, retirement policy and the effective use of the older scientist and technologist are essential features in any adequate policy for scientific and technical man-power, of which the expansion of higher technological education and the supply of science teachers are only special aspects, though no less essential.

THE MECHANISMS OF ORGANIC REACTIONS

Structure and Mechanism in Organic Chemistry
By Prof. C. K. Ingold. (The George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University.) Pp. ix+828. (London: G. Bell and Sons, Ltd., 1953.) 77s. 6d. net.

THOUGH each monograph written by the holder of a George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University is an eagerly awaited scientific publication, Prof. C. K. Ingold's volume arouses special interest, since it is a large and fully referenced treatise which gives the first really comprehensive account of all the work with which he and his colleagues have been concerned during the past thirty years.

While Prof. Ingold makes full use of the modern contributions of wave mechanics to valency theory, he clearly shows how present theoretical conceptions are the rational outcome of a century of active research and speculation, and not just qualitative applications of approximate mathematics of recent origin. Thus, typically, when discussing aromatic structure, he points out that what are now called 'observed mesomeric energies' themselves involve interpretative factors of an arbitrary nature. Again, in discussing theories of chemical reactivity, he stresses the view that thermodynamic factors have no essential concern with reaction mechanism, but that it is essential to know, from experimental work, the complete stereochemistry of each successive phase of any reaction process.

The first four chapters deal with molecular structure and with molecular interactions. The treatment is familiar and rational to those who still believe that one of the main properties of valency electrons is

that they do have a negative electrical charge and not merely mathematical wave-functions. Welcome stress is given to knowledge of the electrical polarizability of organic molecules. Unfortunately the theory of strong electrolytes gets no mention here, for its applications, particularly in connexion with 'salt effects', are often invoked later in critical discussions of reaction velocities.

There then follows an excellent account of aromatic substitution which, with historically complete references, develops up to 1950 the interwoven electrical polarization and electrical polarizability theories which were the greatest achievements of the British organic chemists of the 1920's. A section dealing with *ortho/para* ratios is particularly welcome, since here old facts and modern speculations are often at variance.

Aliphatic substitution processes, elimination reactions and molecular rearrangements of various types receive in all about four hundred pages of detailed discussion. The substantiation of the contrasted unimolecular and bimolecular types of heterolytic organic reactions is, of course, the main achievement of the school of British chemists at University College, London, and hitherto it has been very difficult for any outsider to comprehend the import of each item of experimental evidence. Now that the subject can be judged as a whole, the vital importance of reaction velocity measurements can be realized. Often it is seen that the exact magnitudes of reaction velocities are of as much importance in deciding upon reaction mechanism as are reaction orders, or the accelerating or retarding effects of substituents.

Many topics which have been, and some which still are, controversial receive discussion in these chapters; but so masterly is the logical development of the argument that it is difficult for even a critical reader to recall much of the divergent speculation of past days, or the cogent experimental evidence upon which it had been based. There are, however, significant contributions to this field of chemistry, originating outside London, which receive little or no discussion. Hammett's empirical equations relating chemical reactivity to chemical structure, and the use of 'competition factors' in connexion with the second, fast, stage of unimolecular substitution processes, are instances which I have noted. Some, but not all, of these omissions may be deliberate. For example, 'hyperconjugation' is rather pointedly treated as a second-order influence upon chemical reactivity. When reading these chapters of the finished book one can visualize its origin, with the meticulous British advocate lecturer facing his American audience and stifling minor criticisms by his sheer mass of factual information. Overwhelming evidence has been given to show that the full electronic theory of chemical reactivity, as developed from the time of Lapworth, is both more adequate and more applicable to experiment than the restricted American resonance theory.

Unfortunately, the last hundred pages of this book, dealing with acidity, catalysed reactions, and similar topics, are disappointingly incomplete, as if Prof. Ingold, having completed the review of the topics which are of personal interest to him, had decided that the remainder of theoretical organic chemistry was of minor importance. This is certainly untrue, for problems of acid-base catalysis, the roles of Lewis acids in electrophilic substitution, and synthetic applications of the generalized Claisen-type reaction

are as essential to organic chemistry as are aliphatic substitution processes. There are, however, other excellent monographs which deal with these subjects, and it is too much to expect of anyone that he should devote the time and energy to discuss the whole of the theoretical background of organic chemistry in equal detail.

Judged as a whole, "Structure and Mechanism in Organic Chemistry" is a classic of scholarship which will for a long time be regarded, in Britain at least, as the authoritative treatise upon theories of heterolytic reactions. It does mention that there are also homolytic reactions, but refrains from any discussion of them. As has been pointed out, it must be recognized that the book advocates a particular point of view; but since this is that of the scientific worker who is primarily an experimentalist it will receive the hearty approval of all who call themselves chemists. Prof. Ingold's admirers have hoped for a long time that he might eventually be induced to write a book such as this: in its detail and wealth of references it certainly surpasses all expectations, while in regard to its clarity of exposition it is typical of Prof. Ingold at the top of his form.

W. A. WATERS

SCIENCE AND RELIGION

Natural Religion and Christian Theology

By the Rev. Charles E. Raven. (The Gifford Lectures 1951, First Series: Science and Religion.) Pp. vii + 224. (Cambridge: At the University Press, 1953.) 21s. net.

THE first volume of Dr. C. E. Raven's Gifford Lectures contains a survey of the work of the early naturalists, of its relation to other scientific studies and to the general climate of thought. This historical survey is made for a theological purpose. For Dr. Raven, 'natural theology' and 'natural history' are closely linked, as they were for the great John Ray, who said "Divinity is my profession" and made it the scientific study of the organic world. Ray's attitude was characteristic of British men of science of the seventeenth century, but is not so popular now, when many see themselves as technocrats. His attitude has also been rejected by some theologians, ancient and modern. These theologians of the extreme other-worldly view, and the technocrats, of whom the Marxists are the most consistent, both take the same view of science: the first to condemn, and the second to attribute magical virtues to science. For these theologians the natural world is obscure and unintelligible, if not actually given over to the powers of darkness, and those who profess to study it must do so for greed of gain or from even worse motives. The Marxist, granted his inversion of the criteria of good and evil and the consequent changes in terminology, says the same. Both deny that there is any real natural order or any real natural world to be discovered, much less to excite wonder and admiration. Dr. Raven argues against the theologians that if they were right the doctrine of the Incarnation would be self-contradictory, as would the whole Hebrew tradition about the relation between the creatures and the Creator. He does not trouble to argue with Marxists or technocrats, but treats the scientific side of the matter historically. This is necessary because so much writing on the history of Western science puts

physics, especially experimental physics, in the foreground and all the rest dimly in the background. If you do that you practically accept the Marxist view, for experimental physics creates a world of artefacts and considers the world outside the laboratory, if at all, as analogous to that inside. Fortunately, some physicists are not mere artificers and can see that there is a natural order; otherwise there would be a disastrous split between the sciences.

The attitude of the naturalist is fundamentally religious and aesthetic, and, as Dr. Raven indicates, in all probability the first naturalists in Western Europe were the artists. It is an attitude which in its primitive form comes easily to people living under simple conditions closely linked with earth and sea and sky and the living creatures around them. Dr. Raven points to the excellent observation of Nature to be found in Chapters 38 and 39 of the Book of Job and other parts of the Old Testament. On the other hand—and this is a point he might have made more explicit—this attitude does not come at all easily to unfortunate people whose horizon is confined to the modern industrial urban conglomeration of artefacts.

Valuable features of the book are the tribute to the neglected sixteenth-century naturalist, Conrad Gesner, and to the Cambridge Platonists, who mediated between science and religion during the seventeenth century. Altogether this is a fascinating and illuminating book.

A. D. RITCHIE

A REVIEW OF THE PLANT KINGDOM

Plant Morphology

By Prof. Arthur W. Haupt. (McGraw-Hill Publications in the Botanical Sciences.) Pp. ix + 464. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 64s.

THE title of Prof. Haupt's new book, while admittedly correct, is perhaps rather misleading, and plant taxonomy might have been a more appropriate title. It is a survey of the principal groups of the plant kingdom, all of which are dealt with from the point of view of structure, reproduction and development. It is intended to be used as a two-semester course, supplemented by appropriate practical work, and a good general elementary knowledge of botany is assumed. For students in Britain it should comfortably cover most of the systematic botany needed for a general degree.

The author has ranged widely over the plant kingdom and finds room to include most groups in more, or less, detail. In so doing, some will feel he has thrown his net rather too widely. Some groups, like the Isoetales, Psilotales and Laboulbeniales, or even more, the Acrasiales and Labyrinthulaceae, and, perhaps, one or two of the algal groups, might with advantage have been left out. In little more than four hundred pages, of which a good deal of the space is occupied by illustrations, there is none too much room for so large a project, and, for the type of student for which the book is intended, it might have been preferable to give a little more space to some of the larger groups. On the other hand, it may be contended that the book should be used as a reference book as well as, or perhaps rather than, a text-book, and that the inclusion of such groups as

those mentioned, if only for brief mention, is desirable. Certainly with the short but carefully selected bibliography, a student should have no difficulty in supplementing the information which he is able to obtain from this book.

It is a pleasure to pick up a new book, and an American one at that, which uses an old and familiar classification, and justifies so doing. Rhodophyceae and Phaeophyceae still serve, in place of the newer but less euphonious Rhodophyta and Phaeophyta, while few will regret that the author has not found it necessary to use the term Tracheophyta.

There are more than three hundred illustrations, of which about two-thirds are original. These illustrations, as a whole, are of high quality and form a valuable part of the book. The photographic illustrations are particularly clear.

Any reviewer might glance through Prof. Haupt's book and discover features which he did not like or on which he felt he might improve. Nor would it be difficult to direct attention to errors and to statements capable of misconstruction. To do so would be less than fair to the author. By modern standards, he has undertaken a big task and one which might have been farmed out among specialists; but in that way the book would not have achieved an individuality, and that it undoubtedly possesses. F. W. JAMES

PHYSIOLOGY OF THE ALGAE

The Metabolism of Algae

By Dr. G. E. Fogg. (Methuen's Monographs on Biological Subjects.) Pp. x+149. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1953.) 8s. 6d. net.

THE extreme diversity among the algae has presented a compelling challenge to the development of classical phycology based primarily upon studies of morphology, life-history, taxonomy and ecology. A few algae have been selected for the physiological study of cellular processes such as photosynthesis and various aspects of membrane phenomena. Yet there have been few attempts to seek out and define those general or comparative aspects of physiology which characterize the group. The only two reviews of the subject, by L. R. Blinks¹ and J. Myers², did not appear until 1951 and were so limited in the field covered and divergent in point of view that they showed very little overlap. It is timely and appropriate that a more complete treatment of metabolism, the central core of algal physiology, should come from Dr. G. E. Fogg, an active member of a vigorously contributing group in University College, London.

The introductory chapter presents an abridged classification of algae and a classification of nutritional types which provides the basis of organization of the following chapters. Photosynthesis is presented as a necessarily brief survey of a large body of information. The attempt is directed toward exposition of the essential features of the process and the variations in terms of pigment participation and hydrogen donors observed among the algae. A chapter on chemotrophic assimilation provides a more complete synthesis of scattered observations and considers the spectrum of relationships between photosynthetic and oxidative assimilation of carbon. The topic of nitrogen assimilation includes consideration of nitrogen fixation in the blue-green algae and ammonia

and nitrate assimilation as observed principally in *Chlorella*. Amino-acid requirements now known for species of *Euglena* and *Chlamydomonas* are treated separately in a short chapter, together with the few known cases of vitamin requirements, under the title of heterotrophic assimilation. The carbohydrate, lipid and nitrogenous cell constituents are considered both as products of metabolism and as distinguishing biochemical characteristics of the various algal classes. A chapter on growth and metabolism is concerned with their inter-relationships. The thesis is set forth that, as a result of minimal excretion and versatile metabolism, changes in environmental conditions may give rise to a great range of variability in cellular composition in the simpler algae. A final four-page summary chapter presents the necessary apology for the limited sampling of algae on which generalizations must be based and reiterates some of the salient ideas of previous chapters in justification of algal metabolism as a distinct field of study.

Since the book will have impact upon future treatments of the subject, criticism should be made of the nutritional nomenclature upon which it is organized. The 1946 Cold Spring Harbor Symposium on Quantitative Biology proposed an elegant and precise classification of nutritional types of micro-organisms³. The nomenclature was later applied to the protozoa by A. Lwoff⁴ and now is applied to the algae by Dr. Fogg. Thus algae may be classified as phototrophs or as chemotrophs, depending upon whether the chief energy source is provided by photochemical or chemical reactions. Subclasses of photo- or chemo-lithotrophs or photo- or chemo-organotrophs are distinguished by their requirement for inorganic or organic exogenous substances. The classical terms 'autotrophy' and 'heterotrophy' are relegated to what is now a minor distinction based upon ability to synthesize essential metabolites. However precise the classification and however logical it may have appeared in 1946, there are now arguments against its continued use. It is cumbersome in terminology. It has had only limited acceptance in the field of microbiology for which it was designed. It does not necessarily group together organisms most closely related metabolically, and its separation into different groups implies far more profound differences than actually may occur. For purposes of discussion of metabolism of the algae, the classification is not a necessity, and at several points it leads to awkwardness of organization. Question is raised as to the desirability of its continued use.

The book is broader in its scope than a review. At the same time, its small size precludes the detailed treatment of data and the criticism and speculation which might be expected of a more exhaustive treatise. It is not directed toward the specialist in the field. It will orient but will not critically instruct the student who desires to work in the field. It serves well the stated purpose of bringing together the scattered literature "into a general account of the subject which will be of interest to students of botany, microbiology, and biochemistry".

J. MYERS

¹ Blinks, L. R., "Physiology and Biochemistry of the Algae", 203-291; in "Manual of Phycology", ed by G. M. Smith, chap. 14 (Waltham, Mass.: Chronica Botanica Co., 1951)

² Myers, J., *Ann. Rev. Microbiol.*, 5, 157 (1951).

³ Cold Spring Harbor Symp. Quant. Biol., 11, 303 (1946).

⁴ Lwoff, A., "Biochemistry and Physiology of Protozoa", 1-26. (New York: Academic Press, Inc., 1951.)

AIRBORNE MAGNETIC SURVEYS

ON November 27 the Royal Astronomical Society held a Geophysical Discussion, with the Astronomer Royal, Sir Harold Spencer Jones, in the chair, at which the post-war development of a method of carrying out magnetic surveys from the air was reviewed. So far, experience has been mainly confined to measurements of the variation of the total intensity of the geomagnetic field; but experiments with apparatus for measuring three components of the geomagnetic field are in progress in the United States, Canada and Great Britain.

Mr. J. Squires, of the Research Laboratories of Elliott Brothers (London), Ltd., described the 'fluxgate' measuring element, which consists of a high-permeability core surrounded by an a.c. energizing winding able to drive it into saturation. Since saturation occurs twice per cycle, an output signal composed of even harmonics of the drive frequency is generated, predominantly second harmonic when the core is only just saturated but containing up to the fortieth harmonic when driven well beyond saturation. In either case the presence of an external field affects the output which, after rectification, may be used for indicating the intensity of the field component along the axis and its sense. Mr. Squires gave details of the design and operation of fluxgate instruments, the sensitivities of which, under laboratory conditions, are 10–12 $\mu\text{V./}\gamma$ and 35–40 $\mu\text{V./}\gamma$ for the second harmonic and peak types, respectively. Corresponding noise-levels are 0.03 γ and 0.1 γ .

When used in aircraft, the measuring element is aligned along the earth's field by two other fluxgates mounted mutually perpendicular to it, the whole orientated by servo-mechanisms which maintain the two latter elements in zero-field conditions. In order to measure very small changes in fields, it is necessary to 'back-off' most of the main field, and this may be done by an auxiliary winding on the core fed from a temperature-stabilized battery. Drifts of less than 3 γ per hour are attainable. The fluxgate measuring-head may be either towed from, or mounted in a suitable part of, the survey aircraft. In the latter case, compensation for the aircraft's own field is necessary and may be achieved with small permanent magnets or strips of high-permeability material. 'Noise-level' after compensation is usually 1–2 γ . Mr. Squires mentioned that another form of measuring element, dependent on the change in a.c. resistance of a high-permeability wire when subjected to a magnetic field, might have applications in airborne survey work.

Mr. A. B. Malone, of the Anglo-Iranian Oil Co., Ltd., stated that the oil industry is interested in outlining deep sedimentary basins, where sufficient sediments might exist to permit oil accumulation. He thought that there is a good deal of over-optimism in the United States as to the ability of the airborne magnetometer to define depths to the crystalline basement and even to outline structure in the overlying sediments. From the nature of magnetic data, there can be no such certainty of interpretation. Depth calculations can be of two kinds. If the field is continued downwards until the anomalies become impossibly great, or if the magnetic anomalies are assumed to arise from 'point' sources, maximum depths can be assigned. Alternatively, one can assume the form of the causative body and calculate

depths to the body on that assumption. It is this latter method which has proved so successful in America. The anomalies are assumed to arise from large rectangular blocks having a different susceptibility from the surrounding basement rocks. The walls of the block are assumed to be vertical and extend downwards to great depths. It seems unlikely that the basement could everywhere be imagined to be of this nature; and, in fact, total magnetic intensity maps show that over large areas of the world it is not, as the anomalies are small in lateral extent and very irregular in pattern. When the depth of the basement increases, the anomalies merge into one another to produce finally a smooth picture with no anomalies of any magnitude. This is in marked contrast to the large regular anomalies found in the Bahamas and on the American continent over sedimentary strata exceeding 20,000 ft. in thickness.

On depth calculations in general, Mr. Malone said that the ordinary methods of Vacquier¹ would be of doubtful utility in such an area, as it is obvious that, with increasing depth to the basement, the anomaly pattern becomes smoother as the sharp anomalies merge into one another. One method, which appears to be useful in certain areas, is to select a part of the total intensity map where basement depths are known or could be estimated, and measure the average 'sharpness' of the anomalies over that part of the map. The total intensity map of this area is then extrapolated upwards, and the mean sharpness again measured at various heights. This enables the sharpness criterion to be related to depth, and the depths to basement over the whole area of the map can then be roughly estimated. In order that isolated values of the sharpness should not be given undue weight, some smoothing of the final map may be desirable. In areas such as the Bahamas, Mr. Malone thought that the anomaly pattern is such that Vacquier's methods would be applicable, although this has not been examined. This area was surveyed before the publication of Vacquier's book, and a different method was used. Here the anomalies were supposed to arise from truncated cones, and magnetic fields for a series of such cones were calculated and compared with the observed anomalies.

Mr. H. F. Finch, of the Royal Greenwich Observatory, referred to some observations recently made in America, where an airborne magnetometer has been employed to measure absolute intensity and direction of the magnetic field. From these measurements it is possible to calculate the values of the other elements. The results obtained appear, in general, to be good within $\frac{1}{2}^\circ$ in declination, and to within 200 γ in the horizontal and vertical components of the earth's magnetic field. Mr. Finch has been able to confirm this order of accuracy from a comparison of some of the airborne results, corrected for the effect of altitude, with land observations made in the same regions. The general pattern of the field, as given by the airborne observations, is also in good agreement with that reduced synthetically from the results of a spherical harmonic analysis made at the Royal Greenwich Observatory in the course of preparing the Admiralty Magnetic Charts for the epoch 1955.0.

Mr. P. A. Rankin, of Hunting Geophysics, Ltd., London, described the execution of an aerial magnetic survey. His organization used a Canco flying boat with the magnetometer head in a fixed position

under the tail. Latterly, a Percival Prince aircraft has been converted; the magnetometer head is fixed in the tail and is a universal one which can be used in any latitude, for low or high magnetic dip. The positioning is done by a 35-mm. cine camera, which exposes film at such intervals that the whole of the ground beneath the aircraft is recorded, the magnetometer record being marked at each film exposure. Generally, where the object is to outline geological bodies which lie close to the surface of the ground, the spacing of the magnetic profiles is of the order of $\frac{1}{2}$ mile and the flights are made at a height of 500 ft. above ground. However, where the magnetic material is deeper, as in the case of mapping the basement underlying oil areas, the spacing can be 1, 2 or 4 miles and the height can be a constant at 1,500–2,000 ft. above sea-level. The technique of magnetic control is to fly a series of lines, called control lines, around a network of fixed magnetic values, which act as datum values for the readings on the flight lines themselves. Where there are areas of low magnetic relief, this method is practical; where, however, the area is magnetically disturbed, it may only be possible to use selected points instead of lines. Whichever method is used, the aircraft flies over these points or over a series of points (called 'loop points') at least twice within, say, ten minutes. This allows the diurnal drift of the field over that period to be calculated. It is, of course, assumed that the daily variation is linear for that time period. A stationary magnetometer of the fluxgate type is run at the flying base so that during a magnetic storm flying can be stopped. Esterline-Angus curvilinear tape 5 in. wide was the early type of record used; the Leeds-Northrup tape, rectilinear 10 in. wide, has latterly been used, allowing for an easier reduction of data.

Next, Mr. Rankin described the reduction of the data obtained to produce total-intensity maps. The control network values must be determined, errors of closure around the network distributed and final values marked on the control lines, as plotted on the map. Values at intersections of control and flight lines are then determined, and thus values along the flight lines are determined and marked on the map and the contours finally sketched in. Mr. Rankin then illustrated how simple geological structures appear on aerial magnetometer maps (Figs. 1 and 2). Fig. 1 shows a strongly magnetic gabbro plug outlined on an airborne magnetometer map at 500 ft. altitude. The direction of plunge, known from

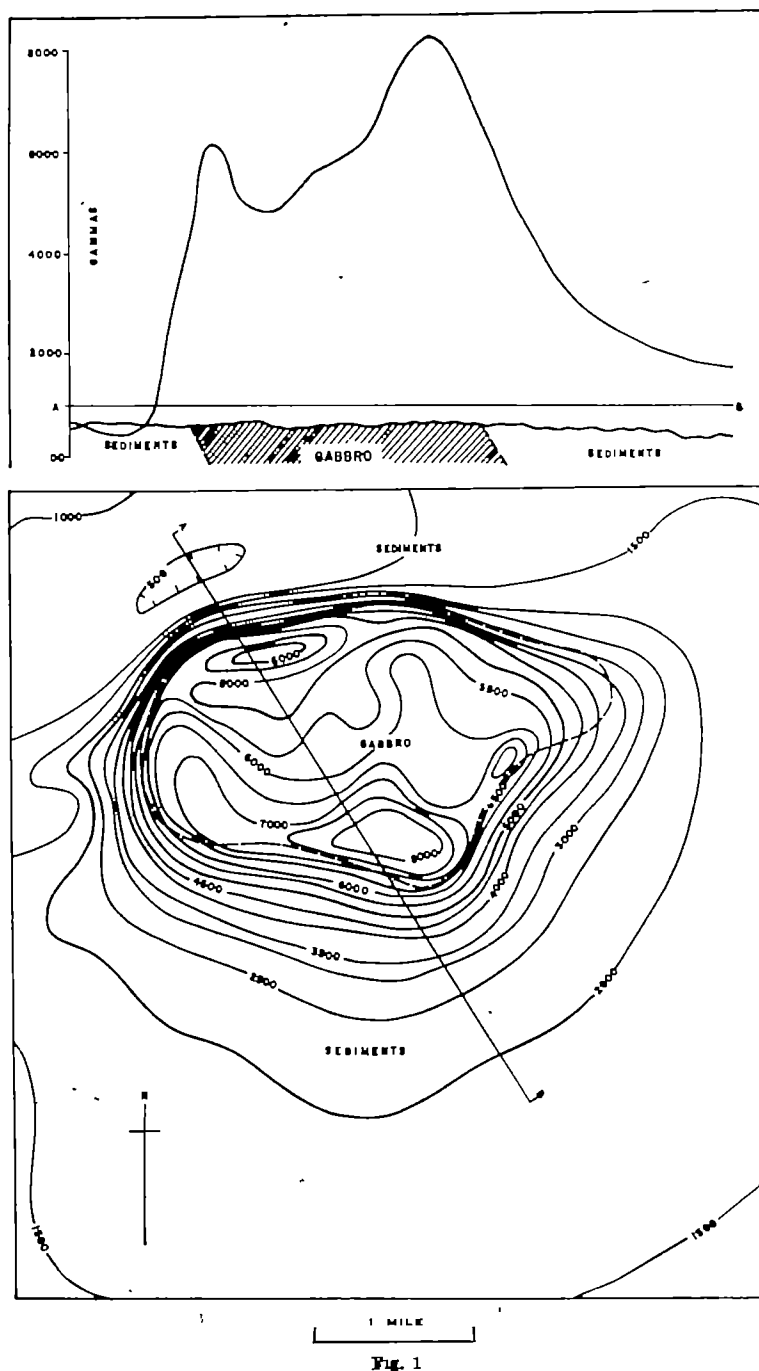


Fig. 1

geological work, can be interpreted from the magnetic profile. Fig. 2 shows a sharp anomaly produced by a sill-like body of serpentinized peridotite. The shoulder on the north-west side of the anomaly is caused by a belt of volcanic strata. The asymmetry of the profile is related to the south-west dip of the serpentine.

Dr. S. K. Runcorn, of the Department of Geodesy and Geophysics, University of Cambridge, pointed out that magnetic surveys are the one type of airborne geophysical survey likely to be available for a long time to come and would be used extensively in hitherto unexplored areas of the world. Their success in picking out ore bodies has been striking, and ho

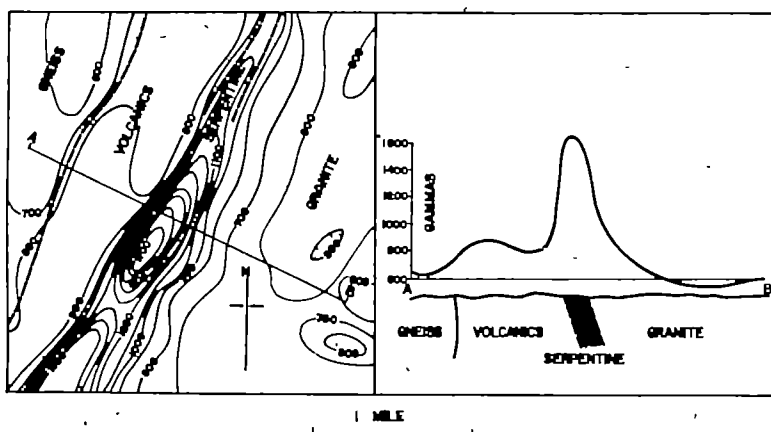


Fig. 2

referred to the discovery by the Aero Service Corporation of Philadelphia, using such surveys, of an extensive iron-ore body beneath the property of the Bethlehem Steel Co. at Morgantown, Pennsylvania. This body lies under 1,500 ft. of limestone, and previous extensive geological and ground survey failed to locate it; it is apparently dangerous to under-estimate the economic potentialities of this new method of exploration.

Apart from the well-marked magnetic anomalies of such ore concentrations, one has mainly to consider the anomalies caused by the surface contours and polarization variations of the basement rocks. Usually highly contorted and of igneous or plutonic origin, these rocks will have high intensities of magnetization (approximately 10^{-3} gauss) due to a high content, a few per cent, of iron oxides and due to the thermoremanent magnetization acquired on cooling after deep burial or metamorphism or from a magma. Apparently such thermoremanent magnetization is greater than the induced magnetization in the earth's present magnetic field, and as there is now much evidence that the direction of the field, both in declination and dip, has varied considerably over geological times, the validity of the interpretation of magnetic anomalies in terms of variations in intensity, but not in direction, of the polarization of the basement rocks is in some doubt. Some of the ferromagnetic constituents of rocks are unstable magnetically, and the polarization of rock samples containing these oxides will rotate into the direction of the field in which they are placed. Such effects may be more general at the higher temperatures at depth, and over long times, and the assumption of a basement magnetized along the present direction of the geomagnetic field may in the end be justified. The sedimentary stratum covering the contorted basement rocks is often flat-lying and normally has a low intensity of magnetization (say, 10^{-6} gauss) owing partly to the segregation of the heavy minerals due to erosion and deposition and the absence of effective processes of magnetization as in the case of igneous rocks.

Scientifically, airborne magnetic surveys are of enormous interest in view of the rudimentary nature of our knowledge of the structure at depth and especially the differences between the oceanic and continental areas. It has been pointed out by Deel² that there are apparently no anomalies of intermediate extent between those which can plausibly be attributed to the current systems of the main

geomagnetic field in the depths of the mantle and core and those anomalies the origin of which lies in the ferromagnetism of the crust. Consequently, the depth to the Curie-point isotherm where rocks cease to have ferromagnetic properties bears a relationship to the width of the magnetic anomalies observed at the surface. Recently, the discussion of the temperature distribution and radioactivity heat generation in the earth's crust has been renewed by the discovery that the geothermal gradient in the ocean bottoms seems to be nearly the same as that in the continents, despite the absence of a granitic layer of relatively high radioactive

content.¹ Consequently, the depth of the Curie-point isotherm under the oceans and the continents may be very different, and a comparison of the width of the magnetic anomalies obtained over oceanic and continental regions, such as could be easily obtained by the total-intensity aerial magnetometer, would be of great interest.

Dr. Runoorn concluded by suggesting that an aerial magnetic survey of the British Isles is much needed for comparison with the wealth of geological and gravitational data available. S. K. RUNOORN

¹ Vacquier, V., Steenland, N. O., Henderson, R. G., and Zietz, I., *Mem. 47, Geol. Soc. Amer.* (1951).

² Deel, S. A., *Pap. U.S. Coast Geod. Surv.*, No. 664 (1945).

THE R. W. PAUL INSTRUMENT FUND

UNDER the will of Mr. R. W. Paul, who died in March 1943, the R. W. Paul Instrument Fund was established, and in 1945 a committee was set up composed of three representatives of the Royal Society and one each of the Physical Society, the Institute of Physics and the Institution of Electrical Engineers. This committee is empowered by the terms of the Trust to receive applications from British subjects who are research workers in Great Britain for grants for the design, construction and maintenance of novel, unusual or much-improved types of physical instruments and apparatus for investigations in pure or applied physical science. These grants may be made for or towards the provision of equipment, building facilities or financial or other aid, in such a manner as the committee may determine; but grants from the Fund may not be used to relieve expenditure in any establishment controlled by the Government or to relieve any university or other educational establishment of its normal financial obligations.

Since its inception the committee has voted £56,350 in respect of some eighteen instruments, some of which are mentioned below.

The mechanical forces exerted by electromagnetic fields have been applied to the measurement of microwave power in work now in progress by Prof. H. M. Barlow and Dr. A. L. Cullen in the Electrical Engineering Department, University College, London. A practical torque-operated wattmeter for the absolute measurement of microwave power in the

range 10–60 W. at 3 cm. wave-length with an accuracy of about 1 per cent has been devised by Dr. Cullen; its calibration involves measurements of mass, length and time only. Efforts are now being made to use electrical and mechanical resonance for the measurement of smaller powers at shorter wave-lengths.

A vibration gravimeter has been constructed by Mr. B. C. Browne and Mr. R. L. G. Gilbert, Department of Geodesy and Geophysics, in the University of Cambridge. The gravimeter consists essentially of a vertical filament tensioned by the weight of a constant mass. The natural frequency of transverse vibrations of the filament depends on the tension and hence on the local value of gravity. This frequency is measured by comparison with a crystal-controlled frequency standard. Even if the frequency fluctuates, the average value can be determined with an accuracy better than one part in a million. The gravimeter can therefore be used on an unsteady support. It has been used to measure gravity in a submerged submarine¹ and has now been adapted for remote operation for investigating the vertical gravity gradient in a borehole².

In Lord Charwell's laboratory at Oxford two spectrometers have been developed. One, a photoproton spectrometer, measures the energy of gamma-rays above 2.2 MeV. Photoprotons are produced by gamma-rays in a deuterium-filled (5 atmospheres pressure) ionization chamber. After amplification their pulse-height spectrum is analysed by a 25-channel kick-sorter. Mono-energetic gamma-radiation will produce a single photoproton peak, and not a continuous pulse-height distribution. It is possible to detect very weak radiation in the presence of a strong background of radiation of lower energy. In this way a new line in the spectrum of sodium-24 at 3.7 MeV. (intensity 1/2,500) was found³. The energy of a photoproton depends on the angle of emission with respect to the beam. This makes it possible to determine the angular distribution by analysing the shape of the pulse-height, which is of theoretical interest. Measurements have been made for gamma-energies of 2.76, 2.62, 2.51 MeV.⁴. The techniques and equipment developed for this instrument are also used in connexion with the investigation of gamma-rays with a Compton spectrometer and a pair spectrometer^{5,6}.

The energy of fast neutrons is usually determined from the spectrum of recoil protons (hydrogen-filled ionization chambers, organic scintillating crystals, photographic plates). These methods have the common disadvantage of poor resolution and difficulty in the interpretation of results. In the fast-neutron spectrometer developed, only those recoil protons are selected which have suffered a head-on collision. This is achieved by measuring coincidences between pulses produced by recoil protons due to the primary neutrons in a stilbene crystal and pulses produced in a sodium iodide crystal surrounded by a layer of silver (1 cm.) by capture gamma-rays from the scattered neutrons. By means of a time delay (3×10^{-8} sec.) neutrons which have lost at least 99 per cent of their energy in the stilbene are selected. The instrument gives a peak for mono-energetic neutrons, not a continuous spectrum. It has an energy resolution of 5 per cent at 2.5 MeV. This instrument has been adapted for the measurement of the energies of low-lying levels of nuclei excited by the inelastic scattering of fast neutrons⁷.

In the analysis of a crystal structure it is necessary to measure hundreds and even thousands of integrated X-ray diffraction intensities from the crystals. Much of this is done by eye estimation; but higher accuracy of experimental measurement can be achieved by photometry of photographs. Photometry of ordinary X-ray photographs, however, is exceedingly tedious because no really satisfactory integrating photometer has yet been produced. The alternative, proposed by Wiebenga and Smits (1950), is to cause the integration to be done by giving the actual X-ray camera a scanning motion during exposure, so that a single photometric measurement in the centre of the resulting spot gives the integrated intensity directly. Prof. E. G. Cox and Mr. D. S. Beard, of the University of Leeds, have designed an integrating mechanism which can be fitted to a Weissenberg goniometer of British manufacture and which gives results of high accuracy. Although the mechanism is costly to make, it eliminates the need for an even more costly photometer, since a very simple photometer suffices for the measurements required; and although it increases the time needed for taking X-ray photographs, it reduces very greatly the time required for their measurement.

The purpose of an interference microscope constructed by Dr. D. Gabor, of the Electrical Engineering Department, Imperial College of Science and Technology, London, is to obtain a complete record of microscopic objects in two photographs; moreover, these records are obtained with a small fraction of the illumination required in ordinary instruments, by making use of an amplification principle. It is hoped that ultimately this may be used in the microscopy of light-sensitive organic structures. In the new microscope a coherent light beam is split into two unequal parts. The smaller part passes through the object, which is in one branch of an interferometer, while the larger part, the 'coherent background', passes through the other. Each beam is split into two, and a quarter-wave phase shift is produced between the two background-beams. These are then paired with the two image-carrying beams, and produce two photographs on a plate, side by side. Whether the object is focused on the plate or not, these two photographs contain a complete record of the image wave. The densities in corresponding points are proportional to two amplitude components, in quadrature with one another. Reconstruction is carried out in the same apparatus by illuminating the photograph with two uniform waves, again in quadrature to one another. The reconstructed beam can be explored in depth, in dark field, bright field, amplitude contrast or phase contrast, just as if one had the original object under investigation.

Prof. A. V. Hill, with Dr. D. K. Hill and Dr. D. R. Wilkie, has been working in University College, London, on new types of galvanometers and radiometers and on apparatus for studying material at high pressure. The problem of constructing galvanometers of short period (for example, 5 msec.) with sufficient sensitivity has been solved by employing photoelectric amplification of the deflection. The short period requires a very light moving coil, and the high magnification demands extreme freedom from extraneous disturbance. The latter is achieved by (a) symmetry of the moving system, involving very accurate construction, (b) using alternate springs and masses in the mounting. The magnified deflection is displayed on a cathode ray tube. Several such galvanometers have now been in use for years,

at sensitivities normally obtained with instruments of 1-2 sec. period.

Two chambers have been constructed for studying the effects of high pressure (up to 1,000 atmospheres) on muscular contraction. These are very satisfactory, the pressure being easily produced. The rapid changes occurring after stimulation must be recorded externally. Difficulties are provided by (a) the small size of the pressure chamber, (b) having to fill it with salt solution, and (c) electric leaks. Moreover, no existing electro-mechanical transducer is suitable for high pressures under these conditions, and new techniques must be devised. These difficulties are being overcome and preliminary results have revealed various interesting new effects.

Dr. H. H. Hopkins, of the Technical Optics Section of the Physics Department, Imperial College of Science and Technology, London, has designed a static scanning fibrescope the aim of which is to provide a flexible unit capable of transporting optical images along its length. Upwards of 50,000 fibres of glass, of a type such as the boro-silicate crowns giving high transmission, are aligned in a regularly arrayed bundle, some 0.20 in. square and 30 in. long. An optical image formed on one end-face of the bundle is now transferred to the other end, since the light falling on any one fibre is 'trapped' in that fibre because of total internal reflexion. A transmission of 25-50 per cent is expected in the final instrument; and already, even using coarser fibres, detail 0.005 in. in size can be resolved and the image is of good contrast. A particular use in view for the fibrescope is gastroscopy and similar medical techniques.

A small diffraction-grating ruling engine is being built by Dr. A. H. Holbourn and Prof. R. V. Jones, of the University of Aberdeen, to test the possibility of controlling the line spacing by direct reference to a light-wave interference pattern. This would eliminate the errors arising from the use of a screw. The pilot model is intended to produce concave gratings 8 cm. $\times$ 5 cm.; the absence of periodic errors should give ghost-free spectra. The technique of using light waves directly for mechanical control, which has been developed specially for this ruling engine, may have other applications.

Dr. O. Klemperer, of the Physics Department, Imperial College of Science and Technology, London, has constructed an electron spectrometer of high resolving power which will be useful whenever fine structures in any electron spectrum have to be investigated. The instrument uses a short magnetic deflexion field of very small aberration for the dispersion of the electron spectrum. A magnetic lens forms an intermediate image of the source closely in front of the deflexion field, while the deflexion field, acting as an astigmatic lens, projects the final image of the source on the collector slot. The spectrometer can be used for beta-rays of 10⁴ eV. For weak beta-sources, the greatest possible collecting power is required, and for this purpose a four-pole magnet has been used. This is inserted between the deflexion field and collector slot in order to counteract the astigmatism of the deflexion field and so to shorten the line image down to the length of the collector slot. A resolving power of about 1,000 has been obtained with a collecting power of about 1/1,000. The spectrometer is being used at the moment for an investigation on quantum losses of electron energy at inelastic collisions in solids. Electrons of only 5-10 keV. are transmitted through thin films, and

discrete losses of 10-20 eV. are measured. Here an increased resolving power is obtained by decelerating the rays down to 800 eV. before they enter the deflexion field. In this way the resolution has been increased sufficiently to locate the lines in a spectrum of a 10-keV. beam within a fraction of a volt.

A team of workers under Prof. N. F. Mott in the University of Bristol is developing a meniscus Schmidt meteor camera—a camera of wide aperture and short focal length, with a large field. After experience obtained with a small camera made from plate glass (aperture 6.5 in., $F/0.7$ (nominal)), the construction of a small-scale pilot model was commenced and is now nearing completion and should be ready for use this March. This will have a focal ratio of $F/0.63$ (nominal) or $F/0.78$ (effective), with a field of 56°. The stop diameter is 8.6 in. (focal length 5.4 in.) and mirror diameter 17 in. The full-scale model will have a mirror of diameter 28 in. The lens and mirror systems of these cameras have been designed independently; it has not been possible to compare them with the American models, full details not being available. The shutter system is original and avoids drilling holes in the mirrors through which to pass the rotating axle; the use of curved photographic plates is also unique to the Bristol instrument, the coating of these plates having been already accomplished successfully. The camera will be used in conjunction with the radar equipment at Jodrell Bank, Cheshire, to photograph meteors; a rotating shutter enables velocities to be measured. Information such as luminosity, velocity and decelerations will be obtained. From these observations, physical conditions in the upper atmosphere and collisions between molecules of high energy can be investigated.

A conventional spectrometer, in which the detector scans the elements of the spectrum one at a time, is inefficient in that only one element out of the whole spectrum is actually being observed at any moment. In the multichannel spectrometer being constructed by Prof. R. O. Redman at the Observatories, University of Cambridge, this loss is avoided by applying modulation patterns to the intensities of the spectral elements in such a way that they may act on a single detector simultaneously throughout the whole time of observation and yet be separable at the output of the detector. In the instrument under construction, the modulation is effected in a two-beam interferometer without the use of any dispersing system such as a prism or grating. The multichannel spectrometer should be specially valuable for faint radiation sources in the infra-red, and if successful will ultimately be applied to infra-red stellar spectra.

Information about application for grants from the R. W. Paul Instrument Fund can be obtained from the Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1.

¹ Gilbert, B. L. G., *Proc. Phys. Soc.*, B, **63**, 445 (1949).

² Gilbert, B. L. G., *Nature*, **170**, 424 (1952).

³ Beghian, L. H., Bishop, G. R., and Halban, H., *Phys. Rev.*, **83**, 186 (1951).

⁴ Beghian, L. H., Bishop, G. R., and Halban, H., *Phys. Rev.*, **83**, 1052 (1951).

⁵ Hicks, D., Humlin, T., Sanders, L. G., and Beghian, L. H., *Phys. Rev.*, **90**, 163 (1953).

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THE ADULT FEMALE LOWER JAW FROM MAKAPANSGAT

By Prof. RAYMOND A. DART

University of the Witwatersrand

IN Makapansgat Valley near Potgietersrus in the Central Transvaal on July 29, 1953, Mr. Alun R. Hughes, senior technician in the Department of Anatomy, University of the Witwatersrand, recovered from the Limeworks dump, which has previously yielded cranial and pelvic remains of adult, adolescent and infantile specimens of *Australopithecus prometheus*, the major portion of an undistorted adult and probably female mandible.

The accompanying photograph (Fig. 1) illustrates first the specimen itself and secondly its appearance (below) in comparison with (above) the infantile *A. africanus* mandible from Taungs (Dart, *Nature*, 1925) and (centre) the adolescent *A. prometheus* mandible from Makapansgat (Dart, *Amer. J. Phys. Anthropol.*, 1948).

These three australopithecine mandibles, collected during the past thirty years, fortunately are all undistorted. Each preserves virtually the entire dentition at the crucial growth stage it represents. Simultaneously, they display collectively the anatom-

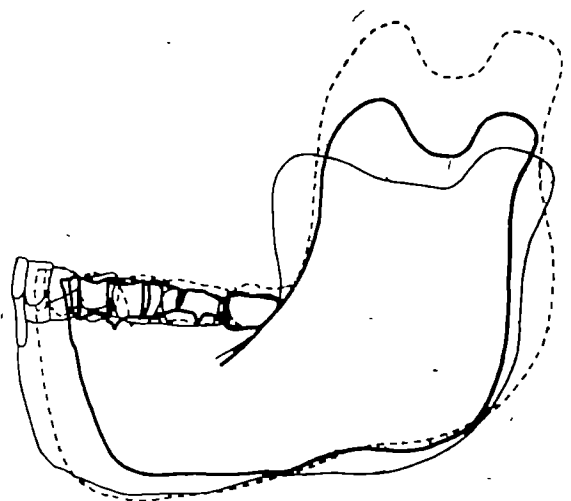


Fig. 2. Outlines of jaws of: *Australopithecus prometheus*, —; *Paranthropus crassidens*, ----; Heidelberg man, —. $\times 3/5$ natural size

ical details of the lower jaw and its dentition in a complete and unqualified fashion. The growth process as well as the form of the australopithecine mandible, both subsequent to and preceding the establishment of the milk dentition, was indistinguishable from that which occurs in mankind.

The new adult jaw is unique at the moment, because it is the only one so far to have preserved the entire incisor-canine-premolar-molar dental arcade without warping, compression or dental dislocation. Although the lower third of the symphyseal region was blasted away, little of the essential anatomy of the jaw is lost. From the adult occipital and craniofacial, and the adolescent mandibular fragments of *A. prometheus* recovered in 1947 and 1948, a provisional reconstruction was made available in 1950 to all museums and anthropologists at cost, through the generosity of the American Institute of Human Paleontology and the Wenner-Gren Foundation which assisted in founding it. It is gratifying to record that scarcely 2 mm. alteration is necessary in the dimensions of the profile, or norma lateralis, of that reconstruction for its mandibular contour to correspond with that of the specimen now under discussion.

The most remarkable feature of this, the most nearly human of all known South African man-ape dentitions, is that the dental arcade can be superimposed tooth for tooth upon the dental arcade of Peking man. The dental length in the promethean man-ape is actually less. The chord of the dental arcade from the mesial border of the medial incisor to the distal border of the third molar measures 75 mm. in Peking man and only 73 mm. in the Makapansgat man-ape. The bicanine width in the *Sinanthropus* male is 37.5 mm. and in the *A. prometheus* female 35.5 mm. The width of the second molar in the primitive man from China is 14.0 mm. and in the proto-human individual from the Transvaal 14.5 mm. Actually, the Makapansgat premolar-molar series of teeth is slightly larger, while the incisor-canine series is slightly smaller, than the corresponding Peking series.

The Makapansgat mandible is shorter and more robust than that of Peking man, but definitely much shorter and less robust than those of its near South African relatives *Plesianthropus* and *Paranthropus*,

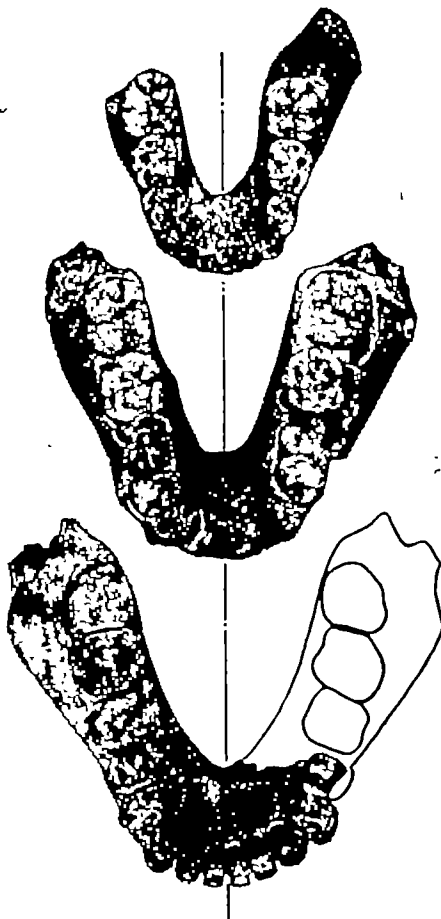


Fig. 1. Upper: infant *Australopithecus africanus* (Taungs). Middle: adolescent *Australopithecus prometheus* (Makapansgat). Lower: adult female *Australopithecus prometheus* (Makapansgat). $\times 3/5$

showing the wide range of potential variation at the australopithecine phase of human evolution. The really astonishing fact, however, is that this mandible is considerably smaller (see Fig. 2) than the mandible of Heidelberg man. There is no satisfactory means of distinguishing the lower jaw or its teeth in *Australopithecus prometheus* from those of some of the primitive human beings already known to science.

In their jaws and dentitions as in their postural uprightness and predaceous habits, the South African man-apes were human. There is no known criterion whereby the Australopithecines can be excluded from the zoological status of an intermediate family of creatures having the brains of apes and the bodies and nutritional habits of mankind.

OBITUARIES

Prof. Robert A. Millikan

THE distinguished American physicist, Dr. Robert A. Millikan, died on December 19, after an illness of several months, at his home in Pasadena, California; he was eighty-five years old. Dr. Millikan was born in Morrison, Illinois, on March 22, 1868, the second of six children. His father, Silas Franklin Millikan, was a Congregational minister. Before her marriage, his mother, then Mary Jane Andrews, was Dean of Women of Olivet College, Olivet, Michigan.

Millikan attended Oberlin College at Oberlin, Ohio, where he received his A.B. degree in 1891 and his A.M. degree in 1893. He held a research fellowship at Columbia University during 1893-95, when he received from that institution his Ph.D. degree. The following year he continued his study and research at Berlin and Göttingen.

In the autumn of 1896 he was appointed an assistant in the Physics Department in the University of Chicago. In his twenty-five years at that University Dr. Millikan progressed through the academic ranks to become one of that institution's most outstanding professors. In 1921 he went to Pasadena, California, as the chairman of the Executive Council of the California Institute of Technology and also served as director of the Norman Bridge Laboratory of Physics. He retired from these positions in 1945, but continued his active participation as a vice-president of the Board of Trustees of the Institute and as a research worker in the Norman Bridge Laboratory.

The Nobel Prize in Physics for 1923 was awarded to Dr. Millikan for his precision evaluation of the electronic charge e and of Planck's constant of action. The Hughes Medal of the Royal Society, the Comstock Medal of the U.S. National Academy of Sciences and many awards, honorary degrees and academy memberships have clearly shown the world-wide recognition and distinction that he deserved and received. His most important contributions were in the measurement of the charge of the electron, the photoelectric determination of Planck's constant, the bridging of the gap between the ultra-violet and X-radiation, and his explorations of cosmic radiation. In addition to these major fields of research, Millikan contributed substantially to many other fields. With unusual physical stamina and energy, he was able to spend more than sixty years in active participation in physical research. It was characteristic of most of his research that many hours of painstaking observation and analysis were required for the problems

undertaken. Measurements made with great care were repeated many times to obtain from his equipment the greatest accuracy. Careful analysis of the data yielded experimental facts that enabled him to refine both his equipment and his analysis of the data to give results in physical measurements of remarkable precision. The great variety of fields in which he made important contributions emphasizes his unusual ability in recognizing and developing critical and important areas for research.

Dr. Millikan's contributions to education in the United States brought him many honours and recognition as a great educator. As a college student he taught physics in a preparatory school and found the text-books available unsatisfactory. His first years at the University of Chicago were partially occupied with a programme of writing texts for preparatory school and first-year university courses. His text-books, widely used throughout America for half a century, have been important influences in scientific education. In the creation and development of the University of Chicago he was a strong advocate of the concept that departments should be composed of a group of independent scholars, one of whom, for administrative purposes, is chosen as a chairman. In the California Institute of Technology he developed an outstanding engineering school combined with a very distinguished and able graduate school in basic science. The thousands of graduates of this unique institution are now a very important influence in American technology. The development of the National Research Council was due, in a large measure, to the efforts of Millikan. The post-doctoral National Research fellowships provided a substantial group of able research scientists who were the leaders of the National Defense Research Council and of its projects in the Second World War. Millikan was, himself, an active worker in the military forces in the First World War. In the second his Institute, with many staff members on leave to military and scientific research, carried on a large training programme for military students, and at the same time developed and produced important military weapons.

Millikan began his career at the time of a great revolution in physics. He witnessed and participated in the initial discussions regarding the nature of cathode rays, X-rays and radioactivity. The radical ideas of the quantum theory and of the theory of relativity were supported enthusiastically by the young Millikan.

The period following the First World War was a transition period for the world, and also for Dr. Millikan. The practical applications of scientific discoveries had led to such radical changes in transportation, in communication, and in industrial and chemical production that the century was marked as the scientific era. The homage paid to science for the part it has played in changing our concepts of matter and life brought on an attack from those who saw a conflict between science and religion (for example, the 'monkey trials' in Tennessee). With Millikan's move to the California Institute of Technology he became the spokesman for those who believed that science was neither materialistic nor irreligious. In taking this conservative position, Millikan received great acclaim from many religious groups. In assessing his own success, Millikan gave credit to Divine guidance or a "good fairy" for the opportunities that came to him.

His wife, Greta Blanchard Millikan, died two months before his own death. His eldest son, Clark

B. Millikan, is professor of aeronautics at the California Institute of Technology. His second son, Glenn A. Millikan, who was professor of physiology at Vanderbilt University, was killed in a mountaineering accident in 1947. Glenn Millikan's wife was Claire Mallory, daughter of George Leigh Mallory, the Mount Everest climber. His youngest son, Max F. Millikan, is professor of economics in the Massachusetts Institute of Technology.

ROBERT B. BRODSKY

Prof. Oldřich Tomíček

PROF. O. TOMÍČEK's death, which occurred after a short illness on October 21 a few days after his sixty-second birthday, is a heavy blow to Czechoslovak analytical chemistry, for during the past twenty-five years he has been the leading analyst and pharmacist at the Charles University. He was born in Prague on October 10, 1891, where his father was a pharmacist, and early showed his scientific ability in publications with Prof. B. Brauner. Thus young Tomíček was predestined to the study of pharmacy and reached the degree of *Pharmaciae Magister* shortly before the outbreak of the First World War, in which he had to serve in a military pharmacy in Innsbruck. It is significant of the zeal of the young scientist that he found an opportunity of approaching Prof. K. Bruner to pursue special work on indol derivatives in the laboratories of the University of Innsbruck. The end of war brought Tomíček back to Prague and gave him the chance to widen his scientific knowledge at the Charles University under the guidance of the inorganic chemist Prof. Štěpán Böhmi. Here he took the degree of Ph.D. in June 1920 and was appointed university assistant. The years 1923-24 Tomíček spent in Utrecht in the laboratory of Prof. Schoorl to acquire potentiometry. There started his friendship with the rising scientist, I. M. Kolthoff, which proved most influential for the further development of Tomíček's line of research and lasted—supported by frequent meetings of both men at various international gatherings—until Tomíček's death. The two friends worked out the foundations for the use of titanous chloride in potentiometric titrations.

Later on, as assistant professor of analytical chemistry in Prague, Tomíček worked on the potentiometric determination of cerium and started with his school a series of studies of volumetric determinations in strongly alkaline medium. His chief work in that direction was published in the *Journal of the American Chemical Society* during 1935, where he gave practical applications for the titrations of cobalt, manganese, bismuth, thallium and cerium, using amalgams for the reduction, and ferricyanide, hypochlorite or hypobromite for oxidation. In that year Tomíček was nominated full professor.

In 1943 he started to study potentiometric and polarometric titrations in non-aqueous solutions, chiefly in glacial acetic acid. This line of research required special attention from the theoretical aspect as regards the meaning of neutralizations and pH values. These discussions are therefore of high theoretical value and of fundamental interest, promising also possibilities of wide practical applications.

Prof. Tomíček was also held in high regard in pharmaceutical circles, being co-editor of the Czechoslovak "Pharmacopoeia" and revising the

analytical problems involved. He was expert also in forensic chemistry.

As a university teacher, Tomíček proved an excellent lecturer, devoted to his pupils. For them he wrote in Czech several valuable text-books on quantitative and volumetric analysis. Of his scientific monographs the best known and appreciated is "Chemical Indicators", which was translated into English (Butterworth, London, 1951). Besides this, Tomíček contributed at the international level to the "Handbuch der analytischen Chemie" (J. Springer, Berlin, 1944 and 1948) with accounts on ammonium, oxygen, sulphur, selenium and tellurium. In his own country, also, Prof. Tomíček was highly esteemed. For many years he was president of the Czechoslovak Chemical Society, of which he was made an honorary member, president of the Pharmaceutical Society and corresponding member of the Czechoslovak Academy of Science.

Tomíček was an extremely kindly man, always willing to help his numerous friends, colleagues and pupils, and inclined to overwork himself for unselfish reasons. His non-academic interests were mountaineering, motoring and skiing. Thus not only in scientific minds, but also in many hearts, Prof. Tomíček's death has left an open gap.

J. HRYBOVSKÝ

Dr. F. C. Minnett, C.I.E., M.B.E.

DR. F. C. MINNETT, director of the farm livestock research station of the Animal Health Trust, died on December 26 at the age of sixty-three.

Francis Colin Minnett was born on September 16, 1890, and was educated at King Edward's School, Bath, the Royal Veterinary College, London, and the Pasteur Institute, Paris. He qualified as a veterinary surgeon in 1911 and worked for the next three years in the pathology department of the Royal Veterinary College under Sir John MacFadyen. During 1914-24 Minnett was an officer in the Royal Army Veterinary Corps. He then became a research officer of the Ministry of Agriculture's veterinary laboratories until 1927, when he was appointed director of the Research Institute of Animal Pathology at the Royal Veterinary College; in 1932 he became professor of pathology. In 1939 Minnett went to India as director of the Imperial Veterinary Research Institute at Mukteswar. On the division of India he became commissioner for animal husbandry in Pakistan until 1949, when he joined the staff of the Animal Health Trust. At the request of the Foreign Office, he was soon seconded for two years as veterinary adviser to the Turkish Government.

Minnett was a prodigious worker, mainly upon bacteriological problems concerned with disease in animals. He was a strenuous bench worker throughout his life, although he never neglected—indeed he encouraged—the translation of laboratory work to the farm. His work was mainly concerned with diseases of cattle, and he studied in turn bovine tuberculosis, contagious bovine abortion, Johne's disease, foot and mouth disease and mastitis. He also investigated mastitis in sheep, blackquarter, anthrax, strangles in horses, mortality wastage among livestock in India, and the health of animals as affected by climatic conditions. In all, he published more than fifty papers in scientific journals.

Probably the main work which Minnett did was to focus attention on the serious loss in Great Britain occasioned by mastitis in cattle. He divided the

Streptococcus forms into three groups, and it was shown that his Group I coincided with *Str. agalactiae*, information which was already known in other countries. He and his colleagues were the first to point out the etiology of his Group II, which is known as *Str. dysgalactiae*. His Group III is now known as *Str. uberis*. Probably the best defence that Minett ever gave for the work which he and his colleagues did is in an article published in the *Journal of Hygiene*, 35, 504 (1935). This was in answer to an attempt by some medical bacteriologists to delve into a veterinary problem. His work also included the demonstration that certain human strains of *Streptococcus* could affect the udder of the cow, and

in turn that affected milk may cause an outbreak of human disease. He directed attention to the toxin production of *Staphylococci* of animal sources; these differ in some degree from the human pathogens. His work on John's disease was largely concerned with methods of isolation and types of media, in addition to collaborating with others in the diagnosis of the disease, particularly by Johnin.

Minett was a strenuous worker, who expected equal work from his junior colleagues; he appeared stern, but beneath an apparently hard exterior he was warm-hearted and full of fun. His early death is a great loss to British veterinary science.

W. R. WOOLDRIDGE

NEWS and VIEWS

Mr. Cecil Warburton: 100th Birthday

ON February 6, Mr. Cecil Warburton celebrated his hundredth birthday. Mr. Warburton entered Christ's College, Cambridge, in 1876. He became a demonstrator in the School of Agriculture and in the Department of Zoology in the University, and later he was a member of the Quick Laboratory which eventually grew into the Molteno Institute. Mr. Warburton has always had wide interests in general entomology and was for many years honorary zoologist to the Royal Horticultural Society (of which he was elected a life member at the age of ninety-six). He has published papers, etc., on spiders, and wrote the section on Arachnida in the "Cambridge Natural History" (Macmillan). Perhaps his best-known scientific work is on the ticks, in collaboration with the late Prof. G. H. F. Nuttall, which led to the production of the standard monograph on this economically important group of animals. For many years now, Mr. Warburton has been a living confutation of the gerontologists, for he has maintained in almost legendary degree his activity of body and of mind—at least he still plays bridge and chess (at which many years ago he represented the University of Cambridge), he is still a dangerous opponent at croquet, and solves *The Times* crossword puzzle each day. At the luncheon given in his honour on the eve of his birthday by his old College, he responded with a lively speech; he was also entertained at luncheon on his birthday by his colleagues at the Molteno Institute of Parasitology.

Geology at Belfast:

Prof. J. K. Charlesworth

ALTHOUGH The Queen's University in Belfast has an ancestry going back more than a hundred years, its chair of geology was founded only in 1921. The first occupant, Prof. J. K. Charlesworth, this year retires from the service of the University in the proud knowledge that the task of creating a department almost from its foundations is visibly fulfilled in the newly completed building that forms such an adornment to the University's post-war fabric—though it must be a source of keen regret to him that he has been able to occupy his new rooms for so short a time. After graduating at Leeds under P. F. Kendall, Prof. Charlesworth carried out research and obtained his doctorate at Breslau. He finally moved to Belfast from a senior lectureship at Manchester. His academic interests have been mainly in Pleistocene geology, especially in the history of the Ice Age in Britain; and his work has achieved world-

wide distinction for the manner in which he has elucidated late-Glacial changes and described the deposits of the Newer Drift in England and Wales, the recession of the ice in southern Scotland, and the intricacies of successive glaciations in Ireland. These contributions will shortly be rounded off with an elaborate analysis of the glaciation of the Scottish Highlands. In ancillary studies he has discussed the origin of the Irish Sea, and of the Irish fauna and flora. He has, however, never been narrowly content with specialist interests, but has used his position to popularize geology as a cultural subject, not least through his recently published book on the geological history of Ireland.

Dr. Alwyn Williams

PROF. CHARLESWORTH is to be succeeded by Dr. Alwyn Williams, a graduate and former Fellow of the University of Wales. While at Aberystwyth, he elucidated the complex structures of the classical Llandailo district, and began his studies in Lower Palaeozoic fossils. Thereafter he spent a year at the Sedgwick Museum, Cambridge, with Prof. W. B. R. King. In 1948 he went with a Commonwealth fellowship to the United States National Museum, Washington, where he worked with Dr. G. A. Cooper on fossil brachiopods, a group in which his main interest lies. Some of his researches on the morphology and taxonomy of protrematous forms have been the subjects of monographs issued by the American Geological Society. Since 1950 he has been lecturer in geology in the University of Glasgow, and has extended his work on Lower Palaeozoic rocks from Wales to the Southern Uplands. The wide outcrop of similar rocks running south and south-west from Belfast will give him further opportunities of applying his special knowledge when he takes up his appointment in Ireland.

Physics in the National Physical Laboratory:

Dr. Ezer Griffiths, O.B.E., F.R.S.

DR. EZER GRIFFITHS recently retired on his sixty-fifth birthday from his position as a senior principal scientific officer in the Physics Division of the National Physical Laboratory. Appointed shortly before the First World War, Dr. Griffiths had already done outstanding postgraduate research work at University College, Cardiff, which had culminated in two papers (*Phil. Trans. Roy. Soc.*) on the heat capacities of metals, written jointly with Principal E. H. Griffiths. These early interests have been maintained, for Dr. Griffiths has been in charge of the work on heat

during most of his time at the National Physical Laboratory. By his investigations into the thermal properties of materials and contributions to the science of refrigeration, he has established an international reputation. Twice he went to the Antipodes in charge of scientific investigations: first to study the incidence of brownheart in apples during shipment from Australia, and later to make a survey of the transport of New Zealand lamb. Dr. Griffiths's scientific publications have included three books, "Methods of Measuring Temperature", "Pyrometers" and "Refrigeration Principles and Practice", and about a hundred papers, of which for a joint one dealing with the fundamentals of evaporation he was awarded the Moulton Medal of the Institution of Chemical Engineers. Dr. Griffiths has held offices in many scientific societies, and is still serving as president of the Institut International du Froid. He has been succeeded at the National Physical Laboratory by Dr. R. W. Powell, who has been a member of the Heat Section since 1924.

British Association Secretaryship: Sir George Allen, C.B.E.

SIR GEORGE ALLEN, formerly vice-chancellor of the University of Malaya, has been appointed secretary to the British Association for the Advancement of Science in succession to Mr. D. N. Lowe. Sir George was born in Donegal and educated at the Methodist College and The Queen's University, Belfast. At the University he graduated in medicine. After service with the R.A.M.C. in East Africa during 1917-20, he worked for six years as bacteriologist in the Medical Research Laboratory in Nairobi. He then returned to England for postgraduate work in pathology at Oxford and in London hospitals. In 1928 he was appointed bacteriologist in the Institute for Medical Research at Kuala Lumpur. Shortly afterwards he became principal of the King Edward VII College of Medicine in Singapore; he was also president of Raffles College in Singapore. He assisted the Commission on University Education in Malaya to prepare plans for the creation of a University by the fusion of these institutions, and was the natural choice as first vice-chancellor when the new University was established in 1949. In the three years of his vice-chancellorship Sir George Allen succeeded, with tact and administrative skill, in blending two independent institutions into a thriving entity which is now playing an increasingly important part in the life of South-East Asia. He brings to his new work in the British Association a scientific and medical background, an informed sympathy for experimental and field research and wide experience in education and administration.

Element 99

WITH the ever-increasing amount of effort being devoted to research in nuclear physics, it is perhaps no longer surprising to learn of the production of yet another artificial element—number 99 in the Periodic System (*The Times*, February 3, quoting a statement from the U.S. Atomic Energy Commission). It is well known that there are at least two routes by which new heavy elements may be formed, namely, by successive neutron capture in lighter elements, followed by beta-decay, and also by the nuclear interactions of 'heavy' ions such as $^{16}\text{O}^{++}$, $^{14}\text{N}^{++}$, $^{18}\text{O}^{++}$, accelerated in cyclotrons and used to bombard suitable targets. Both these methods may have been

employed; but only one mass assignment has been made, namely, $A = 247$. The nucleus 99^{247} is understood to decay by alpha-particle emission with a half-life of a few minutes. Although this achievement is not unexpected, it reflects the greatest credit on Prof. G. T. Seaborg, of Berkeley, California, and his collaborators. It will be interesting to learn what name the discoverers will propose for the element. The chemical properties may be predicted with some certainty on the basis of Seaborg's actinide hypothesis, and if such properties are in fact observed, one may refer to the element temporarily as eka-holmium. The rare earth holmium was named after Stockholm. One wonders whether the discoverers of element 99 can find a name for it, based on a place-name, which is anything like so euphonious.

Effect of Germanium on the Transformation of White to Grey Tin

THE (normally) slow transition of the white, tetragonal form of tin to the grey, cubic modification at 13.2°C . is well known, as is the fact that inoculation with the grey allotrope accelerates the transformation. It is now shown in a paper by R. R. Rogers and J. F. Fyde, entitled "Effect of Germanium on the Transformation of White to Grey Tin" (Canadian Department of Mines and Technical Surveys, Mines Branch, Technical Paper No. 5; pp. 11. Ottawa: Queen's Printer, 1953; 25 cents), that inoculation with germanium is similarly effective in producing the grey form, the tin and germanium being immersed in a strong aqueous solution of calcium chloride acidified with hydrochloric acid to pH 1.5 at a temperature of -80°C . Whereas the grey variety made its appearance only after 81 days with the 'pure' tin, 2 per cent of germanium caused its appearance after 4 days in the case of cast tin. It is noteworthy that in the case of hot-dipped tin coatings much longer periods are required than in the case of castings. The presence of germanium in the alloy, or in aqueous solution, has a corresponding accelerating effect. The presence of zinc in the tin results in a marked retardation of the change, the zinc-free alloy containing 2 per cent of germanium first showing the grey tin after 0.9 day at -40°C . as compared with 14 days when 2 per cent of zinc is also present. This effect of germanium is possibly one reason for the well-known difference of different varieties of tin in the rate of transformation, since some tin ores are known to contain small amounts of that element.

Fat from Fungi

IF fats are to be produced by the industrial utilization of moulds, cheap carbon sources such as cellulose waste and molasses must be considered. As sucrose is the major constituent of molasses, the first stage in the relevant investigations is to ascertain the behaviour of different moulds towards it. S. Murray, M. Woodbine and T. K. Walker (*J. Exp. Bot.*, 4, 11, 251; 1953) now report on the growth, development and fat formation of some forty-three strains of ten species of fungi when grown on different sucrose-containing media. The highest three yields of fat were given by *Penicillium janczonicum* van Beyma, *P. soppi* Zaleski and *Aspergillus nidulans* Eidam, in that order. The fat content on felt weight was maximal at 84.8 per cent with *P. soppi*, at 28.4 per cent with *Fusarium lini* (i), and at 25.8 per cent with *A. nidulans*; on sugar

utilized it was maximal at 11.4 per cent with *P. soppi*, at 7.9 per cent with *A. nidulans*, and at 5.6 per cent with *F. liri* (1). Other moulds are considered worthy of further trial.

Roman Gallery at the Grosvenor Museum, Chester

As part of a general reorganization of the Grosvenor Museum at Chester, a gallery previously devoted to art has been entirely ceased in modern style and now illustrates the Roman army. The collections at Chester are particularly rich in Roman material, and it was decided to illustrate the army, and in particular the legions, with special reference to the Chester fortress. The gallery is a long room of nearly 80 ft., and this has been broken up by creating three bays in cases of the shop-window type. This provides a singularly attractive display and provides very useful storage-room. Fluorescent tubes have been used both for the general and individual case lighting. The attention of the visitor is first attracted to a model of a soldier. Then follow panels dealing with a soldier's pay, Samian pottery, tools and equipment, building materials and other objects, leading to a large diorama of the Chester fortress showing its buildings, defences and its relationship to the local topography. The story continues, and to conclude is a final panel illustrating the defences of the Roman Empire.

Electron Microscopy: Conference in London

THE Joint Commission on Electron Microscopy of the International Council of Scientific Unions is sponsoring an international conference on electron microscopy, to be held in London during July 16-21. The detailed organization is in the hands of a committee comprising the members representing the Electron Microscopy Group of the Institute of Physics and members of the Commission resident in Great Britain. Sessions will be devoted to the following subjects: instruments and associated apparatus; electron optics; the attainment of very high resolution; reflexion methods; metallurgical applications; industrial and chemical applications; fixation and drying methods; microanatomy of cilia, etc.; fibrillar structures; structure of cell walls; internal structure of cells; bacteria; viruses; biological specimen techniques; metallurgical and general specimen techniques; and the effect of electron irradiation on matter. All workers interested in the field may attend the conference; they must register with the joint secretaries before March 1 (fee £2). Papers will be accepted for consideration, and authors should in the first instance make their offers to the secretary of the respective national society of electron microscopy, except that in North America they should send them to Prof. T. F. Anderson, 612 Maloney Building, School of Medicine, University of Pennsylvania, Philadelphia 4, and in countries where there is no national society they should send them to the secretary of the programme committee, Dr. V. E. Coslett, Cavendish Laboratory, Free School Lane, Cambridge. Notification of all papers should be made not later than March 1. The official languages of the conference will be English, French and German. An exhibition of electron microscopes, ancillary apparatus and books is being arranged. General correspondence relating to the conference should be addressed to the joint secretaries, Dr. C. E. Challice and Mr. F. W. Cuckow, c/o Institute of Physics, 47 Belgrave Square, London, S.W.1.

Third International Congress of Nutrition, Amsterdam

THE Third International Congress of Nutrition will be held in Amsterdam during September 13-18 under the auspices of the International Union of Nutritional Sciences. The programme will include sessions on the following topics: overnutrition and disease; nutrition and liver disease; parenteral nutrition; nutrition and the psyche; and non-nutrient foreign chemical substances in foods (intentional and unintentional additives). Invitations have already been sent by the local Dutch organizing committee to a number of proposed contributors; but nutrition workers in Britain, particularly members of the [British] Nutrition Society, who would like to participate in the discussions are invited to submit a title and a short synopsis (not exceeding two hundred words) of their proposed contribution for consideration. These should reach Dr. G. H. Bourne, honorary secretary of the Nutrition Society, Department of Histology, London Hospital Medical College, Turner Street, London, E.1, by February 28. Further information about the International Union of Nutritional Sciences can be obtained from the secretary-general, Dr. L. J. Harris, Dunn Nutritional Laboratory, University Field Laboratories, Milton Road, Cambridge.

International Union of Geodesy and Geophysics: General Assembly in Rome

THE International Union of Geodesy and Geophysics will be holding its tenth General Assembly in Rome during September 15-29. The constituent International Associations of Geodesy, Meteorology, Hydrology, Oceanography, Vulcanology, Terrestrial Magnetism and Electricity, and Seismology and the Physics of the Earth's Interior, will meet during the period. Delegates attending are nominated by the national adhering organizations of the Union. British scientists wishing to attend or to read or communicate papers may do so only if sponsored by the Royal Society on the recommendation of the British National Committee for Geodesy and Geophysics. Those wishing to submit papers for the scientific meetings should write to the Assistant Secretary of the Royal Society, Burlington House, London, W.1, not later than March 1.

Training of Biologists

THE Institute of Biology is arranging a meeting, to be held during April 21-22, to discuss the training of biologists. There will be four sessions: on the teaching of biology in schools to those intending to specialize; on undergraduate courses at universities; on biological work in technical colleges; and on postgraduate training. It is hoped that the meeting will attract teachers from schools, technical colleges and universities and representatives of employing bodies. Ample time will be allowed for discussion after the invited papers. A programme will be available early in March from the General Secretary, Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1.

Chemistry Meetings in Eastern Germany

THE Chemical Society of the Eastern Zone of Germany has recently issued details of the meetings it proposes to hold this year. The programme opens with a conference in Berlin during February 23-24 on the place of electricity in chemical industry and

ends at the close of the year with a celebration in Berlin of the 125th anniversary of the *Chemisches Zentralblatt*. Other meetings in Berlin will be one on the manufacture and use of plastics (April 13-14), which will partly be held also in Leipzig, one on dietetics and food chemistry (April 27-28) and another on artificial fertilizers (June 15-16). In Leipzig there will be a symposium on synthetic fibres during March 23-24, followed by the annual general meeting of the Society during October 20-23 and a discussion on the light metals during December 7-8. Finally, a meeting of chemistry *Doxents* will be held in Dresden during May 20-21. Further information regarding these events and the Society in general can be obtained from the Chemische Gesellschaft, Berlin NW7, Unter den Linden 68/70.

Physical Society: Spring Meeting In Dublin

THE spring meeting of the Physical Society will be held in the Department of Physics, University College, Dublin, during March 30-April 1, and will take the form of a symposium on "High-Energy Accelerators and Cosmic Rays", organized by Prof. T. E. Nevin. Speakers from the following institutions have been arranged: Atomic Energy Research Establishment, University of Birmingham, Brookhaven National Laboratory (United States), Dublin Institute for Advanced Studies, University of Manchester, Maynooth College, Queen's University, Belfast, and University College, Dublin. The meeting will be open to all. Application forms and further information can be obtained from the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

Announcements

PROF. A. C. FRAZER, professor of pharmacology and therapeutics in the University of Birmingham, has been elected an associate member of the Royal Flemish Academy of Sciences of Belgium.

LORD CHERWILL, professor of experimental philosophy in the University of Oxford, has been awarded the Messel Medal for 1954 of the Society of Chemical Industry. This Medal, which is the senior award of the Society, is presented once every two years to one who has secured meritorious distinction in science, literature, industry or public affairs, or who is prominently concerned in the welfare of the Society. Previous recipients include Sir Henry Tizard, Lord Bruce of Melbourne and Lord Waverley.

DR. N. H. MACKWORTH, director of the Medical Research Council Unit for Research in Applied Psychology, has been awarded the H. M. Vernon Prize of the National Institute of Industrial Psychology, for his work in directing and developing the studies carried out by his Unit in the field of human skilled performance, and for his personal contribution to a more scientific understanding of the effects of climatic conditions upon human behaviour. This is the first award of the Prize, which was founded by the Institute with a sum of money bequeathed by the late Dr. H. M. Vernon, an investigator of the Industrial Health Research Board and one of the original investigators of the Health of Munition Workers' Committee in 1915. The Prize is to be awarded every second year to the investigator who, being a British subject and under the age of forty-five years, has in the opinion of the Council of the Institute done the most valuable research work in the subject of industrial psychology and physiology.

THE Harrison Memorial Prize for 1953 has been awarded by the Chemical Society to Dr. Ronald James Gillespie, lecturer in chemistry in University College, London, for his work on the electrochemistry of strong-acid solvents published during the five years 1949-53. Dr. Gillespie is at present carrying out research on the dielectric properties of polar liquids at Brown University, U.S.A. The Harrison Prize was created in 1922 to commemorate the services of the late Colonel Edward Frank Harrison, formerly deputy controller of the Chemical Warfare Department, for the protection of the British Forces from poison gas during the First World War. It is awarded to the British chemist, less than thirty years of age, who, in the opinion of the Selection Committee, has during the previous five years conducted the most meritorious and promising original investigations in chemistry and published the results.

PROF. JOHN YUDKIN, professor of physiology in Queen Elizabeth College, London, has been appointed to the University chair of nutrition tenable at that College. The title of professor of civil engineering in the University of London has been conferred on Mr. J. W. H. King, in respect of the post held by him at Queen Mary College, London. The title of reader in photogrammetry in the University of London has been conferred on Dr. E. A. Miakin, in respect of the post held by him at University College, London.

THE Institution of Chemical Engineers is holding a symposium on "Gas Absorption" during April 5-7 in the University of Birmingham. The proceedings will be issued as a special publication (42s., or 21s. to members) obtainable from the Secretary of the Institution at 56 Victoria Street, London, S.W.1. The registration fee of 21s. for the conference (42s. to non-members) includes a set of preprints. Application forms for registering and further information can be obtained by writing to "Symposium", Chemical Engineering Department, University, Edgbaston, Birmingham 15.

THE eighth specialized course on the design, use and maintenance of electronic instruments used in nuclear physics, radiochemistry and in work with radioisotopes will be held in the Isotope School, Atomic Energy Research Establishment, Harwell, during April 5-9. The course, which is for physicists and electronic engineers holding a degree or equivalent qualification, will be limited to twelve persons. The subjects will be entirely unclassified. The fee for the course is 12 guineas plus 5 guineas for those requiring accommodation. Application forms, to be returned by March 26, can be obtained from the Electronics Division, A.E.R.E., Harwell, near Didcot, Berks.

THE United States Office of Naval Research and the University of Pennsylvania are organizing a symposium on "The Origins of Drug Resistance, etc.", to be held in the Hotel Statler, Washington, D.C., during March 25-27. There will be five sessions as follows: origins of drug resistance in micro-organisms; effects of sciridines and resistance to insecticides and herbicides; origins of tolerance and addiction to drugs, and alcoholism; resistance factors in infectious agents and cancer cells; and physiological, chemical and genetic points of view. The symposium is open to all. Further information can be obtained from Dr. M. G. Sevag, Department of Microbiology, School of Medicine, University of Pennsylvania, Philadelphia 4, Pa.

ENGINEERING DIMENSIONAL METROLOGY

SYMPOSIUM AT THE NATIONAL PHYSICAL LABORATORY

THE National Physical Laboratory, Teddington, in co-operation with the Mechanical Engineering Research Laboratory, East Kilbride, recently organized a three-day symposium on engineering dimensional metrology, held at Teddington, during October 21-24, at which forty papers were presented and discussed. Some six countries, in addition to the United Kingdom, were represented by delegates drawn from research organizations and industry. The symposium was opened by Sir Edward Bullard, director of the National Physical Laboratory, who, in welcoming the delegates, commented on the wide field of engineering represented by those present. He spoke of the constant need for proper co-ordination between research and industry, and explained that these symposia at the National Physical Laboratory were intended to maintain and strengthen the bond. In introducing Mr. F. H. Rolt, superintendent of the Metrology Division at the Laboratory, Sir Edward mentioned that Mr. Rolt would shortly be retiring, and referred to this symposium as a fitting 'swan song' for him.

Mr. Rolt's address briefly outlined the history of the National Physical Laboratory, and spoke in some detail of the work of the Metrology Division and its contributions to the scientific and practical applications of measurement in industry. He was followed by the director of the Mechanical Engineering Research Laboratory, Dr. D. G. Sopwith, who described the progress of his Laboratory, which had been founded on a nucleus of sections transferred from Teddington. When completed, this Laboratory should be a fitting counterpart to its parent body in the field of mechanical engineering research.

The first two working sessions were devoted to 'Workshop Inspection', under the chairmanship of Mr. S. J. Harley (Coventry Gauge and Tool Co., Ltd.), who was director of jigs, tools and gauges at the Ministry of Supply during the Second World War, and Mr. J. E. Sears, former superintendent of Metrology Division, National Physical Laboratory, respectively. Dr. H. Törnbohm (Aktiebolaget Svenska Kullagerfabriken, Sweden) dealt in his paper with the wear of gauges, and mentioned how improved design, as well as the use of chromium plating and hard-metal gauging faces, can noticeably increase gauge life. Comparisons between gauging and measuring methods were made in a paper by Prof. G. Berndt (Dresden Technical College, Germany), who contended that, unless the form of the work-piece is geometrically correct, the shape of the measuring anvils or gauging surfaces is often of more importance than the choice of the measuring method itself.

An interesting optical method of inspecting profiles of turbine blade sections was the subject of a paper by M. J. Turrettini (Société Genevoise, Switzerland). The instrument described defines the profile of the blade by illuminating it with a thin belt of light, and the magnified image of the profile is then projected on to a viewing screen. With this method it is even possible to view shrouded sections and, by means of a prism assembly rotated at a suitable frequency, two sections in different planes of the blade can be viewed simultaneously owing to

the effect of the persistency of vision. Another special-purpose instrument, described by Mr. O. O. Taylerson and Mr. A. Turner (National Physical Laboratory), is used for the measurement of internal diameters to an accuracy of ± 0.00001 in. The measurements are made by a pivoted stylus arm to which are attached two mirrors. Differences in size between the diameter being measured and a slip-gauge reference standard produce angular movements of the mirrors, which are measured by means of an autocollimator with an eyepiece scale calibrated in units equivalent to 0.00001 in. Other papers dealt with methods developed in France and Germany for the measurement of screw threads, particularly taper screw gauges to the specifications of the American Petroleum Institute.

M. Vercoûtère (Compagnie Internationale des Machines Agricoles, France) described how the introduction of statistical quality control has assisted the manufacture of agricultural machinery, not only by revealing trends in production but also by giving the machine operators added information on the quality of their work and thereby stimulating their interest in it. This psychological value of quality control was also emphasized by Dr. B. P. Dudding (General Electric Co., Ltd.) in his paper on statistical techniques. The increasing use of mechanized inspection for such difficult work as turbine blades was the theme of Mr. J. Loxham's paper (Sigma Instrument Co., Ltd.), which described multigauging machines incorporating pneumatic indicating devices. Another paper, this time from France, by M. Chalvet (Ministère de l'Industrie et de l'Énergie), dealt with the application of electronics to workshop inspection. During the ensuing discussion it was mentioned that work is being done on the development of electronic devices for gathering and presenting information at present shown in quality-control charts, and the future use of electronics for supplying information to the machine tool and controlling it during its production cycle is also envisaged.

The building of measuring devices into machine tools so as to assist in the dimensional control of the product was advocated in a paper by M. R. Yribarren (Société d'Application de Métrologie Industrielle, France) in the session devoted to pneumatic gauging. It was stated that the introduction of such methods is being delayed by some hesitancy on the part of the operator to accept them for fear that they would lead to loss of craftsmanship, and also on the part of the machine-tool manufacturer for fear that the provision of a measuring device might be interpreted as an admission of functional inadequacy. Much interest was shown in the papers on pneumatic gauging. One, by Mr. L. Polk (Sheffield Corporation, United States), gave a review of developments in the United States, with particular reference to the flow-type of gauge, while another, by Dr. J. C. Evans and Mr. I. G. Morgan (National Physical Laboratory), illustrated the flexibility of the pneumatic gauging technique from examples developed at Teddington during the past five years and ranging from the continuous measurement of fuse wire to the accurate measurement of internal diameters. A quite different application was dealt with in the paper by Dr. K.

Hild (Physikalisch-Technische Bundesanstalt, Germany), which described the use of a pneumatic indicating device in the proving rings used for calibrating load-measuring devices. This session was under the chairmanship of Dr. H. Barrell, who has succeeded Mr. Rolt as superintendent of the Metrology Division, National Physical Laboratory.

A concurrent session on "Machine Tools" was held with Sir William Stanier (Power Jets, Ltd.) in the chair. Increased accuracy in the product has necessitated improvements in machine tools, and Dr. D. F. Galloway (Production Engineering Research Association) emphasized in his paper the value of dynamic, as well as static, metrological tests on machine tools, and also the desirability of testing these machines under load. An autographic method of recording the pitch errors of lathes under running conditions has been developed during recent years at the National Physical Laboratory and was the subject of a paper by Mr. F. H. Rolt. By analysis of the records produced by this method, the sources of error can be traced and, as the test is a dynamic one, irregularities in pitch due to breakdown of lubricating films can be detected. Other papers in this session dealt with methods employed at the Laboratory for testing the accuracy of jig boring machines, and a special lathe for impressing up to 30,000 threads to the inch on highly polished cylinders was described. From the threaded cylinders produced on this lathe, diffraction gratings are obtained by means of the Merton-N.P.L. process—a replica method which eventually, it is hoped, will provide large gratings of very high quality at a low cost compared with the earlier conventional ruling methods. The electronic counting of the 'moiré' bands produced when two diffraction gratings are suitably superposed may be used in the future as an accurate means of controlling linear displacements in measuring machines and machine tools.

Developments in gear metrology at the Mechanical Engineering Research Laboratory were mentioned by Mr. C. Timms in his paper during the session devoted to "Gear Measurement". Examples were given of the use of autographic recording devices in the measurement of both gears and gear-cutting machines, and the conversion of one measuring machine from manual to fully automatic operation enables the measuring of a gear to be made in one-sixteenth of the previous time. During this session, which was under the chairmanship of Dr. H. E. Merritt (Humber, Ltd.), other papers dealt with measuring techniques associated with modern gear-shaving methods and also recent developments in rolling gear testers.

A session devoted to education ran concurrently with that on gears, and Mr. H. J. Shelley (Ministry of Education) was in the chair. The two papers in this section of the symposium dealt with the teaching of engineering dimensional metrology at university and at technical college level, respectively. Prof. H. Wright-Baker (College of Technology, Manchester) referred to metrology as a means to an end in which ever science it is used, and spoke of its disciplinary value to students in achieving precision in their work; the equipment and scope for teaching engineering metrology at Manchester were referred to in some detail. Mr. V. W. Clack (Wandsworth Technical College), in introducing his paper, mentioned that every year about eight students are being trained as designers to each one that is trained as a production engineer. He based this rather disturbing statement

on the examination results, which show that annually about three thousand Higher National Certificates in mechanical engineering are awarded compared with about three hundred and seventy-five in production engineering. Mr. Clack's paper described teaching methods and equipment used at Wandsworth, and contained numerous illustrations of demonstration models of great value for instructional purposes.

Mr. G. A. Whipple (Hilger and Watts, Ltd.) presided at a session on "Small-Scale Metrology" which dealt with problems of measurement associated with the manufacture of watches and small screw threads. Mr. K. J. Hume (National College of Horology) discussed applications of metrology in the horological industry, among which he mentioned the insertion of jewel bearings in a liquid of similar refractive index so as to render possible the inspection of their section by optical projection. The production of very small screw threads down to 1 mm. in diameter and 0.1 mm. pitch, together with the measuring problems associated with this class of work, was dealt with in a paper by Mr. P. R. Brierley (Anglo-Swiss Screw Co., Ltd.).

The subject of "Large-Scale Metrology" provided a contrast to the previous papers, and this session, which was under the chairmanship of Sir Stanley Rawson (Costain John-Brown, Ltd.), illustrated very clearly the difficulties associated with large-scale measurement and also the scope that remains for development in this field. In order to assist the International Organization for Standardization in assigning suitable tolerances to interchangeable parts of large size (greater than 20 in.), investigations are being undertaken in Britain and on the Continent of Europe to assess the accuracy of the industrial measurement of large work-pieces. Two papers were concerned with this work, and in one of them Prof. N. N. Sawin drew largely on the experience of the Skoda Works, Pilsen, to describe in detail the many difficulties encountered in the measurement of large dimensions. An interesting feature was the use being made of wood in the construction of large measuring instruments. When suitably proofed against humidity effects, wood (pine in particular) provides a light stable instrument-frame that is negligibly affected by changes in temperature. The use of wooden-framed instruments was also mentioned in the paper by Mr. T. P. Jolly (English Electric Co., Ltd.), which described measuring methods used in the British heavy electrical industry.

A method evolved in the United States for overcoming the difficulties experienced in manufacturing accurate jigs for aircraft frames was the subject of a paper by Captain O. S. Reading (United States Coast and Geodetic Survey), who paid a tribute to the lead that British optical measuring-instrument manufacturers have given in this field of metrology. How precise measurement contributed to the atomic energy project was revealed in the paper by Mr. V. B. Heasen (Ministry of Supply) on the construction of the atomic pile BEPO at Harwell. Yet another application of large-scale metrology, namely, checking the profiles of large marine propellers, was dealt with in a paper by H. C. Garlick and P. W. Harrison (National Physical Laboratory).

Mr. J. E. Baty (chairman of the Surface Finish Committee of the British Standards Institution) was in the chair for the session on "Surface Finish". The first paper, by M. A. Mirau (Laboratoire Central de l'Armement), dealt with the measurement of surface finish in France, where particular emphasis has been

placed on optical methods of measurement. Besides describing a simplified form of microinterferometer which he has developed, M. Mirau dealt with other optical methods for assessing the bearing area and also the quality of polish of surfaces. The complexity of the practical aspects of surface finish of mating parts was discussed in the paper by Mr. R. E. Reason (Taylor, Taylor and Hobson, Ltd.), reviewing developments and trends in this field. Mr. D. B. Ebsworth (Bristol Aeroplane Co., Ltd.) described methods employed in the production of fine surfaces to the exacting requirements of the aircraft industry. In this work a fine surface finish is required, not only to minimize hand fitting and the period of running-in, but also to reduce the risk of fatigue failure, which so often starts from minute surface defects on the highly stressed components.

On the morning of October 24 the Metrology Division of the National Physical Laboratory was opened to delegates, who were able to see the measuring equipment and methods employed at the Laboratory and also exhibits of equipment arranged by a number of the authors of papers.

H.M. Stationery Office will publish the proceedings of the conference, and these will contain the texts of the papers and a report of the associated discussions.

T. R. J. OAKLEY

THE POTATO ROOT EELWORM AND ITS CONTROL

THE Association of Applied Biologists held a symposium on "The Potato Root Eelworm" at the Imperial College of Science and Technology, London, on January 8, which was well attended and presented a wealth of detailed work, including a demonstration of economic control under certain conditions; some hope for the production of potatoes resistant to the eelworm was also raised. The chairman, Dr. I. Thomas, outlined the magnitude of the problem. Although it is seventy-three years since eelworm cysts were found on potato roots, it was not until 1913 that severe disease was reported from Scotland and Rostock, and the organism was afterwards named *Heterodera rostochiensis*. Since that time, the disease has spread to many parts of the world, half a million acres of arable land being affected in England alone during 1949. About 150,000 acres of potatoes are attacked annually, one-third seriously, giving an overall loss of some 200,000 tons of potatoes worth £2,000,000. In advisory work alone, questions of potato root eelworm absorb a major share of the activities of 80-100 workers who spend about 40 per cent of their time on nematological problems. This last statement by Dr. Thomas seemed, more than any other, to impress members of the conference with the serious nature of the problem.

The morning session was devoted to papers on the hatching of eggs from cysts, and on progress in breeding potatoes resistant to the eelworm. It is vital, in any experimental work with potato root eelworm, to know how many of the contents of the resistant, 'dormant' cyst are still potentially active, and this can be measured by treating the cysts with 'potato root diffusate'—the drainage from potatoes grown in sand culture. Eggs within the cyst hatch into larval eelworms under the stimulus of this

liquid, just as they would when potatoes are grown on eelworm-infested land. Dr. D. W. Fenwick gave the results of his extensive studies of this laboratory measurement. When the numbers of larvae emerging from the cyst are plotted against the logarithm of time in days, a symmetrical sigmoid curve is obtained. Application of probit technique gives a linear relation. Dr. Fenwick then proceeded to show that, since the total number of larvae emerging is twice the number obtained at the point of inflexion of the sigmoidal curve, much time and space can be saved in laboratory determinations, for numbers only need to be estimated for a time sufficient to establish the point of inflexion. The slope of the probit line is a measure of the susceptibility of cyst contents to root diffusate. Practical findings checked by these theoretical considerations include several important items: temperatures between 10° and 25° C. have little effect on the total hatch, although the rate of hatching increases with rise in temperature; hatching is virtually inhibited at 30° C.; pre-soaking of the cysts in water hastens hatching; pH of the root diffusate has no effect between 3.0 and 8.0; sunlight almost inhibits hatching; hatching in a given sample is proportional to the logarithm of the concentration of the diffusate; and since the activities of root diffusate are inhibited in steam-sterilized soil for some weeks, its action appears to be linked with the microflora.

Mr. T. G. Onions spoke on the pattern of hatching from the cyst. He has subjected cysts to the action of root diffusate for a period, and then sectioned them for microscopic examination, to see where the empty, hatched eggs lie. He found most near the vulval end of the cyst, and obtained more from the periphery than from the middle. It was thought that this pattern of hatching might reflect a gradient of oxygen tension.

It would be a great advance in control if potatoes could be bred with resistance to the potato root eelworm. Mr. F. G. W. Jones reviewed the possibilities and progress of this approach. Resistance to this particular eelworm is found in *Solanum ballii* (= *vernii*) and also in *Solanum andigenum*, which may be no more than a variant of *S. tuberosum*. German workers are investigating the possibilities of introducing resistance through crossing potatoes with *S. ballii*, and Dutch and British workers are using *S. andigenum* as the resistant parent. The mechanism seems to be that of a dominant gene responsible for resistance, with tetrasomic inheritance giving the possibility of all degrees of resistance and susceptibility. Practical degrees of resistance as yet attained are rather low; but it might be useful to approach the problem of resistance through some contributory issue. Crosses between *S. stenotomum* and *S. vernii*, for example, have low cyst-hatching stimulus which may add, in practice, to their resistance. Another possible line of approach would be to combine high cyst-hatching stimulus with innate resistance, in order to provide the ideal trap crop, and thereby reduce the effective eelworm population.

The afternoon session on direct control opened with a paper by Dr. B. G. Peters on "Laboratory and Pot Tests of Nematicides". These tests are a first stage in assessment of the value of any material for such control. A certain amount of knowledge can be obtained quickly by dispersing a toxicant under test in water and inoculating it with the vinegar eelworm in a special double-flask culture apparatus. Dr. Peters also described the necessary controls and measurements to obtain the maximum

information from pot experiments—to make allowance for natural death, variations in eelworm population, and other factors. He has, indeed, reduced the technique of such tests to a process as exact as possible, and gave examples of their use with D.D. mixture (dichloropropane–dichloropropylene), ethylene dibromide and other materials. A typical useful practical result from pot experiments is that a single injection with D.D. gave a percentage kill of larvae superior to that with two or three consecutive injections.

Dr. J. Grainger described an economic field control with D.D. on first-early 'Epicure' potato crops in Ayrshire. Increases in yield in numerous experiments since 1947 have been worth about twice the cost of treatment, whether applied at 200 lb. or 400 lb. an acre. Later-lifted crops do not command such high prices a ton as first-earlies, and the yield increase only equals the cost of treatment. Evidence was given for the belief that D.D. has a three-fold action: it can diminish the number of larvae within cysts; it can diminish the number of full eggs in the cyst in the absence of potatoes; and it can stimulate growth of the potato crop directly. Long-term experiments on possible control of potato root eelworm on main-crops grown in a seven-year rotation were described. They are designed to make the best use of the three-fold action, which also supplies the reason for treating first- and second-early crops as long as possible before the potatoes are planted. Dr. Grainger also briefly described his 'Auchinaruive' soil injectors for the application of D.D.; these are now in commercial production. Several results indicated that, for equal quantities an acre, the performance of D.D. was superior when injected as 'spots' at 15-in. centres rather than in continuous traces 12 in. apart. Other materials showing sufficient promise to be investigated on a field scale are ethylene dibromide and inorganic compounds of mercury. These both appear to lessen the build-up of the eelworm population when potatoes are grown, and mercury compounds would be much cheaper than D.D. if they could be mixed finely enough with the soil.

An interesting study on possible control was described by Mr. L. N. Staniland. Phenols, cresols and xlenols and their chlorinated forms give some control of potato root eelworm; but their performance is greatly improved by 'solubilization' with detergents, preferably of the long-chain alkyl sulphate type. They are used as soil drenches at 1 gallon/sq. ft., and at present are quite uneconomic for field application. In the glasshouse, their use is cheaper than steam sterilization, but dearer than D.D. There is, moreover, a danger of tainting the crop. In spite of all these present economic handicaps, however, Mr. Staniland described ways in which performance could possibly be improved. Lower concentrations with more detergent, the introduction of small amounts of iodine, and the performance of different chlorinated compounds are all under test, and Mr. Staniland's audience felt that whether the study ultimately developed economically or not, it would be a sound contribution to the problem.

Prof. H. W. Miles opened the discussion on the morning session of the conference. He said that eelworm study was somewhat neglected in the past, and that the approach to the problem first arose from the farmer. Host-parasite relations are most important for a correct understanding of the problem, and laboratory work is beginning to equal that

devoted to the practical approach. Discussion during the afternoon session was initiated by Dr. W. Healey, who thanked the Association for the opportunities afforded by the symposium, and summarized the economic considerations of direct control arising from the lectures. The use of D.D., he said, comes nearest to practical control at present. It has been suggested that its action might in practice be indirect, putting host and parasite somewhat out of phase. Interesting matters arising from the general discussion are that the breakdown of cysts is slower in peat soils than in loam (Dr. Fenwick), and that potato root eelworm has been found in Peru, one of the native homes of the resistant *Solanum* species. These species are, however, less resistant to the Peruvian strain than to the European eelworm (Dr. C. Ellenby). The question was also raised as to whether a seven-year rotation would itself control infestation of potato root eelworm in practice. Dr. Grainger maintained that the period is not long enough, and certainly not in west Scotland. Infestations capable of causing disease can persist there for 20–25 years in the absence of potatoes. Such results are to be expected by calculation from experiments on the rate of natural loss, and have been confirmed by authenticated advisory cases.

THE RUBBER RESEARCH INSTITUTE OF MALAYA: BOTANICAL DIVISION

THE botanical work of the Rubber Research Institute of Malaya, Kuala Lumpur, for the years 1949–51, as presented in its report, is by way of being an interim account of the five-year plan begun in 1949. Important new developments and discoveries, relating to the extensive investigations now in progress, are briefly indicated under the headings of breeding and selection, propagation and planting techniques, tapping, physiology, and ecology. The programme on breeding and selection deals with such items as pollination, the large-scale production of improved seedlings, cytogenetical studies of *Hevea*, the examination of criteria for selection in the laboratory and in the field, the selection of individuals and clones based on their vegetative characters, the quality and properties of latex and rubber, and selection for resistance to disease, etc.

Studies of propagation and planting technique have related to such matters as the effectiveness of bud-grafting on to mature root systems, the pre-budding treatment of budwood, the storage of *Hevea* seeds, stock-clone relationships, density of planting and distribution, the effect of selective thinning-out, the value of mixed planting of *Hevea* and other crops, for example, cacao, and methods of new planting and replanting. Work on tapping has been concerned with tapping systems for seedling and budded trees and slaughter tapping experiments. Physiological studies of the nutrition of *Hevea* have been continued, attention being paid to the cause of the chronic defoliation in certain clones and to latex flow in response to tapping. Researches of a more fundamental character on the physiology of latex are also in progress. The effects of various injected substances, for example, copper salts, on the yield and properties of latex, and the stimulation of latex

yield by the application of emulsions of various growth-regulating substances, are also being studied. An unusual, if somewhat contemporary, flavour is introduced by the inclusion in the report of instances of sabotage in the experimental fields by terrorists.

VERY-HIGH-FREQUENCY BROADCASTING IN GREAT BRITAIN

IN its first report last year the Television Advisory Committee made recommendations to the Postmaster-General regarding the future of television broadcasting in Great Britain (see *Nature*, August 22, 1953, p. 337). At that time it was stated that the Committee's next task would be to investigate the introduction of high-frequency sound broadcasting as an additional system to the medium- and long-wave transmissions already used by the B.B.C. for its programmes, and now the Committee has published, as its second report*, its recommendations on this score.

The problem before the Committee and its Technical Sub-Committee is that the existing medium- and long-wave services are barely adequate for supplying the general and regional programmes, that they allow no scope for expansion and that, in fact, they are threatened with progressive deterioration owing to the increased interference from Continental stations, mainly those not bound by the Copenhagen Broadcasting Agreement. It is for the most part accepted that the general plan for tackling this problem is to utilize Band II of the frequency spectrum, namely, the very-high-frequency band of 88–100 Mc./s. (3.4–3 m.) that has been allocated by international agreement to Great Britain for sound broadcasting; because the top part of this band is already used by Civil and other services, this in practice reduces the band to the range 88–95 Mc./s. For most broadcasting, such as the existing B.B.C. programmes (including the sound channel of television), the audio-frequencies are impressed on the carrier wave by the method of amplitude modulation; but very-high-frequency waves do offer the practical alternative of frequency modulation, and the Technical Sub-Committee has gone to great lengths to decide which form of modulation to use. This is a problem of many facets, but the main feature that one must assume is that most receivers will have comparatively poor aerials and that most reception areas will be partly screened and subject to a not inconsiderable amount of electrical interference (for the most part amplitude-modulated). For a service comparable with the sound programmes received on long- and medium-waves, the median value of an amplitude-modulated signal at 90 Mc./s. would need to be 1.5 mV./m. generally and 5 mV./m. in large towns; for the same grade of service on frequency-modulation, the signals need only be 0.25 and 0.8 mV./m., respectively. An interesting point noted in the report is that the signal-to-noise ratio of the sound received in conjunction with television is extremely poor, the amplitude-modulated signals at 45 Mc./s. (at which frequency the standard dipole is twice as efficient as one designed for 90 Mc./s.) being about 0.1 and 0.35 mV./m. for the two types of

locality; but from a psychological point of view, the associated visual picture masks the poor signal-strength of the sound.

There are, in fact, three possible types of very-high-frequency broadcasting: frequency-modulation at ± 75 kc./s. deviation, requiring a channel separation of 200 kc./s.; narrow-band amplitude-modulation (channel separation 15 kc./s.); and wide-band amplitude modulation (channel separation 200 kc./s.). For each of these systems to cover 97 per cent of the population of the United Kingdom with three national programmes, the frequency-modulation needs to transmit a total of 760 kW. from 77 transmitters (theoretically 25 per programme, but two extra are needed for Welsh programmes), while the two amplitude-modulation systems require 2,800 kW. from 108 transmitters; the corresponding capital outlays are estimated at £3.5 million and £9 million, respectively, and the annual costs at £800,000 and £2 million. These figures assume a common mast and aerial system for the radiation of three programmes in each area. But the figures for amplitude-modulation are worsened even further if the transmissions in any one area were restricted to a single 600-kc./s. band; for then, due to filtering difficulties, it would be necessary to use three separate, widely spaced masts, or increase the power considerably in a single mast, and in either case the capital and annual costs would be very much increased for such an installation, perhaps as much as doubled.

The report devotes considerable space to the question of receivers, because obviously the introduction of very high frequencies would entail the production of entirely new sets or the adaptation of existing ones, and this is a matter of very great financial importance both to the radio industry and to the public. Though narrow-band amplitude modulation appears on the surface to offer certain advantages, there are in fact considerable difficulties, the principal ones being that oscillator drift in the receiver must be held to the fine limits of 2 kc./s., and it would be very difficult to allocate frequencies which would entail freedom from certain types of interference and also the propagation of interference in the 41–68 Mc./s. band from the receiver oscillator. Thus the choice really narrows down to wide-band amplitude-modulation or frequency-modulation, and as far as receivers are concerned, whether they be adaptors for existing sets or new sets designed for very-high-frequency reception, there seems little to choose between the two systems. As a matter of interest, although adaptors are discussed fully in the report, it is considered that they will be required for only a limited time and that the market for equipment receiving very-high-frequency radiation will eventually be concerned solely with sets designed exclusively for the new type of radiation. Thus the advantage of frequency-modulation is more or less based on the transmitter point of view, though this is not inconsiderable.

The Committee therefore recommends that very-high-frequency broadcasting using frequency modulation should be established in Great Britain, and that this holds good whether sufficient stations are eventually put up to give a national coverage on three programmes or whether the number is sufficient only to provide a substantial reinforcement of the services now given on the long- and medium-waves. This recommendation is signed by nine of the ten members of the Committee, and the dissenting member, Mr. C. O. Stanley, one of the representatives

* General Post Office: Second Report of the Television Advisory Committee (1953). Pp. 25. (London: H.M.S.O., 1954.) 1s. net.

of the Radio Industry Council, has submitted a minority report which is printed in full after the majority report, together with a point-by-point reply by the other members of the Committee to Mr. Stanley's views.

The main feature of Mr. Stanley's arguments is that he does not accept the assumption that very-high-frequency broadcasting need necessarily be introduced in the first place, and that, if it were, the experience of other countries that have introduced it, most of them using frequency-modulation, is decidedly unfavourable. If the plans for very high frequencies go ahead, then the general public will have to start considering buying a completely new receiver, the cost of which for an amplitude-modulator set would be, on the average, £20 and for an equivalent frequency-modulation one £30. Mr. Stanley thinks that the future for the existing broadcasting systems is not necessarily hopeless and that the Committee's first task should be to investigate what may be done to improve them rather than replace them. The reply of the majority of the Committee is that very-high-frequency broadcasting is an unwelcome but inescapable complication, and that its introduction will probably be spread over at least ten years. During that time existing sets owned by the public will tend to wear out and need replacement, and the higher cost of a frequency-modulation receiver is more than outweighed by the advantages of the system.

As in the case of the report on television, the Committee's terms of reference are for the most part concerned with technical problems; but the expansion of television and the introduction of very-high-frequency broadcasting both involve heavy capital outlay by the Government and the development by industry of a wide range of new products, together with the necessity of the general public to find the money for purchasing these products. These are grave economic factors and will, no doubt, be an important, if not over-riding, consideration in any Government decision on these matters.

HORIZONTAL DISPOSITION OF RHIZOMES

THE diageotropic disposition of the rhizome in bishop's weed (*Aegopodium podagraria*) has been attributed by T. A. Bennet-Clark and N. G. Ball (*J. Exp. Bot.*, **2**, 189; 1951) to the action of two hormones working in opposition to one another; both are affected by gravity, and the horizontal position of the rhizome is due to an equilibrium between the effects of the two hormones.

N. G. Ball has now taken the investigation of the mechanism of this intriguing problem—the horizontal disposition of rhizomes—a stage further by examining the effects of several known growth-regulating substances on *Aegopodium* rhizomes (*J. Exp. Bot.*, **4**, 349; 1953). The experimental treatments, which involved the immersing of rhizomes for periods of forty-five minutes in solutions of the growth-regulating substances, were carried out in the absence of visible light, the rhizomes being photographed every hour by infra-red radiation. After immersion in 10^{-4} M β -indoleacetic acid the rate of rhizome growth is approximately doubled; but about five hours later it declines to one-third or less of its original value and then gradually recovers.

This depression in the growth-rate can, however, be reversed by a second auxin treatment, the inference being that the exhaustion of some substance necessary for growth is not involved. It is suggested that the auxin which first accelerates elongation may later be converted into, or may cause the production of, an inhibitor. Thus, when successive immersions in auxin are repeated every two hours, the inhibition can be partially overcome as long as the treatment is continued. As the immersion of horizontal rhizomes in the growth-regulating substance also causes them to turn up, this is taken as giving support to the hypothesis indicated above; that is, an equilibrium is disturbed.

Thus it would appear that when a rhizome is immersed in a solution of auxin there is some mechanism which causes the auxin to accumulate on the lower side. As this may also be assumed to happen to any auxin produced in the rhizome itself, a probable explanation appears to be that the horizontal position assumed by the rhizome results from the balancing of the excess hormone on the lower side of an opposing one. It is pointed out that if the suggestion that β -indoleacetic acid causes an acceleration of growth followed by an inhibitory effect, or that it may itself be converted into an inhibitor, should prove to be generally valid, it would afford a simple and satisfactory explanation of autotropism. The effects of 2:4-dichlorophenoxyacetic acid, ascorbic acid, 2:3:4-triiodobenzoic acid and 2:4-dichloroanisole were also investigated.

STRUCTURES OF NATIVE AND MERCERIZED CELLULOSES

By DR. M. K. SEN and DR. S. C. ROY

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IN a previous publication, Sen and Woods¹ reported the presence of two new equatorial reflexions in the diffraction pattern of native celluloses of various origins. Continuation of this work with more detailed experimentation has now made it possible to make certain assertions with regard to the origin of one of the reflexions, Y. From X-ray photographs taken under various conditions of prevailing humidity, intensity and purity of radiation (including monochromatic radiation) and with different cellulose samples, such as ramie, jute, cotton, viscose and paper, it has been noted that the reflexion occurs in greater or less intensity in almost all ordinarily available cellulose fibres, native or mercerized. Under conditions of 60–70 per cent relative humidity and 70–75° F. temperature, the sharpness, intensity and dispersion of the diffraction maximum are at least equal to those of certain other equatorial reflexions (Fig. 1). The observations regarding its relative intensity in different samples when compared against Meyer and Mark 101 are summarized in Table 1.

Table 1

Samples	Intensity
1. Defatted white jute	Slightly less than that of 101 reflection.
2. Commercially degummed ramie	Less than that of 101.
3. Surgical cotton	Less than that of 101.
4. Ordinary rayon	Slightly less than that of 101.
5. Pre-swollen rayon (treating with ethylene diamine, washing and drying)	Slightly less than that of 101.
6. Mercerized ramie	Greater than that of 101.
7. Mercerized jute	Greater than that of 101 (mercerized).

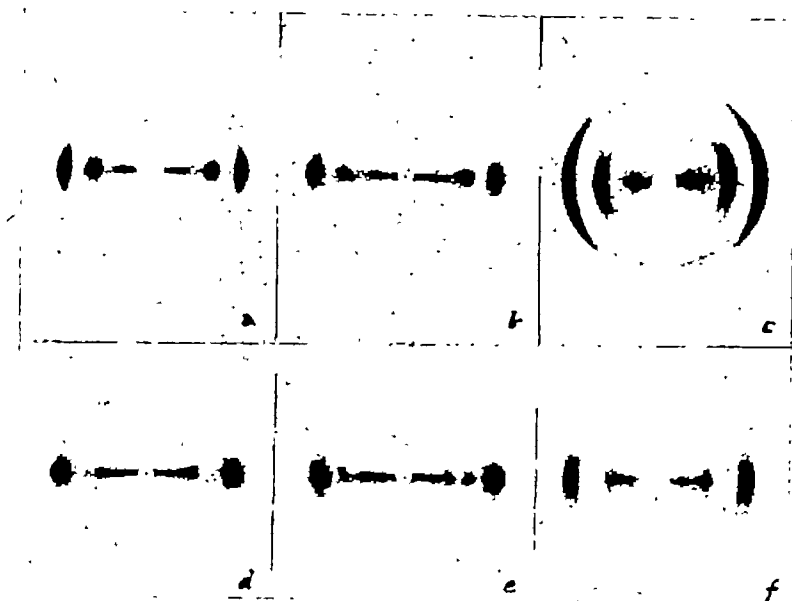


Fig. 1. X-ray photographs with copper $K\alpha$ at 30 kV. and 20 m amp. (a) Native ramie; (b) native jute; (c) native cotton; (d) mercerized ramie; (e) mercerized jute; (f) viscose

In point of sharpness, reflexion Y not only invites comparison with other equatorial spots but in some cases even exceeds them. Its dispersion across the equator runs parallel with the dispersion of the other reflexions and, in relatively more extensible materials such as mercerized ramie and mercerized jute, becomes reduced on progressive stretching.

The spacing at room condition (60–70 per cent relative humidity and 70–75° F. temperature) corresponding to the reflexion for different samples is shown in Table 2.

Table 2

	Spacing (Å.)
Native jute	14.3
" " delignified	13.6
" " alkali-treated (0.3%)	13.6
" " " (1.0%)	13.6
" " " (5.0%)	13.6
" " mercerized without tension	14.0
" " mercerized and stretched (16% shrinkage allowed)	14.0
" " mercerized and stretched (4% shrinkage allowed)	14.2
Native ramie	13.6
" " mercerized without tension	14.7
" " mercerized and stretched (16% shrinkage allowed)	14.4
" " mercerized and stretched (4% shrinkage allowed)	14.5
Cotton	13.1
Viscose	14.8

It is therefore concluded that the reflexion originates from the cellulose crystallites. The difference in the intensity and the variation in the spacing for different samples should arise from the formation of mixed crystals with other polysaccharides and/or absorption of water, which may be the water of hydration or the structural water.

Attempts were made to fit the new reflexion into the reciprocal lattice nets as obtained from the unit cells due to Meyer and Mark⁴, Sauter⁵ and Andress⁶. It was found that none of the hitherto accepted unit cells could account for this reflexion. From analysis of our photographs, it has been possible to fit all the reflexions from native and mercerized ramie as ordinarily obtained into two different unit cells the parameters of which are as follows:

Native cellulose	15.6 Å.	10.3 Å.	12.5 Å.	66°
Mercerized cellulose	16.3 Å.	10.3 Å.	9.0 Å.	64°

The observed and the calculated values of the spacings and the corresponding indices of the planes are shown in Tables 3 and 4.

The cells apply also for cotton, jute and other cellulosic fibres, the only difference being in the slight shift in the 100 plane and hence a small change in the dimensions on account of the inclusion of water or other polysaccharides.

We believe that the Meyer and Mark, as well as Andress, cells for native and mercerized celluloses do not represent the structure of the material under ordinary conditions of temperature and humidity. On the other hand, the cells proposed account for all the reflexions as obtained from flat-film rotation photographs. Furthermore, the theory of the impenetrability of cells of native cellulose by water does not seem tenable, because, as is evident from the changes on moisture absorption in the spacing

due to the 100 plane in native cellulose and those due to the 100 and 200 planes in mercerized celluloses (see also Sen and Woods¹, and Mukherjee and Woods²), varying amounts of water can remain within the cells. This being so, the current concept of the crystalline and non-crystalline regions perhaps needs revision. The ideas might perhaps be best expressed in terms of accessible and inaccessible regions and perfect and imperfect crystallinities, there being no sharp line of division between the two.

The failure of previous workers to observe the newly found reflexion are ascribed to: (a) use of

Table 3. hkl , d_{hkl} and d_{obs} values (native ramie)

hkl	d_{hkl} (Å.)	d_{obs} (Å.)	hkl	d_{hkl} (Å.)	d_{obs} (Å.)
100	13.68	13.70	221	4.29	4.31
102	5.87		221	2.95	
202	5.90	6.01	023	2.96	2.88
002	5.41	5.43	221	3.14	3.22
303	3.93		132	2.59	2.65
403	3.87	3.96	142	2.21	2.18
404	2.79	2.65	331	2.87	
606	1.96	1.96	032	2.90	2.96
014	2.62	2.64	341	2.81	
211	6.19	6.15	042	2.83	2.85

Table 4. hkl , d_{hkl} and d_{obs} values (mercerized ramie)

hkl	d_{hkl} (Å.)	d_{obs} (Å.)	hkl	d_{hkl} (Å.)	d_{obs} (Å.)
100	14.65	14.60	312	2.52	
200	7.33	7.35	513	2.56	2.57
102	4.89		513	2.35	2.39
202	4.46	4.42	021	4.34	4.35
002	4.04	4.03	221	3.40	3.41
003	2.70	2.66	221	2.92	2.98
404	2.23	2.21	223	2.59	2.58
210	5.97	6.02	023	2.39	2.38
012	3.77	3.78	031	3.16	3.14
412	3.41	3.38	132	2.71	
212	2.90	2.91	431	2.62	2.62

large primary beam stop, (b) absorption in fibre bundles due to very thick specimens, (c) use of Sauter camera capable of recording reflexion only within limited angular range, (d) perhaps very dry condition of specimen, the intensity of the reflexion decreasing with the loss of moisture, and (e) low collimation ratio in certain cases and therefore lack of sufficient resolution.

Our results at present do not permit us to draw any conclusions concerning the structure of cellulose in a perfectly dry condition (that is, without the chemically combined last trace of water), and so nothing can be said regarding the validity or otherwise of the unit cells due to Meyer and Mark and Andreas for perfectly dry fibres. A detailed communication on the various issues and far-reaching implications likely to be involved in this new finding is being published elsewhere. Investigation into the probable space-group symmetry is in progress.

[Sept. 23.]

¹ Ben and Woods, *Brooklyn Biophys. Acta*, **8**, 510 (1949).

² Meyer and Mark, *Ber.*, **61B**, 593 (1928).

³ Sauter, *Z. physik. Chem.*, **B35**, 88 (1937).

⁴ Andreas, *Z. physik. Chem.*, **B4**, 190 (1929).

⁵ Mukherjee and Woods, *J. Text. Inst.*, **42**, T309 (1951).

DYE-SENSITIZED PHOTOPOLYMERIZATION

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FREE radicals, except the most stable ones, will initiate the polymerization of vinyl compounds. The free radicals may be produced by the direct photolysis of the monomers, but this requires light of wave-length well into the ultra-violet spectrum¹. Light of nearly ultra-violet wave-length (~ 3000 Å.) will cause the breakdown of substances such as benzoyl peroxide into free radicals which will initiate polymerization². Irradiation of solutions of acidified ferri salts by light of this wave-length will also produce free radicals capable of initiating the polymerization of vinyl compounds³.

Attempts have been made to extend the spectral range of the photopolymerization to the visible region by using dyestuffs as photosensitizers⁴. These reactions, which were carried out in the absence of oxygen, gave low quantum yields for the conversion of monomer. I have shown that the quantum yield for the conversion of acrylonitrile to polymer in water using rose bengal as the sensitizer is considerably enhanced if the solution, irradiated with visible light, contains ascorbic acid and if oxygen is present⁵. In the present communication, the results of our experiments for dye-sensitized photopolymerizations of high quantum yield are summarized. The practical implications of this work are treated elsewhere⁶.

Acrylonitrile in aqueous solution (7 per cent in monomer concentration and buffered at pH 7.0) with fluorescein or one of its halogenated derivatives (eosin, phloxine, erythrosine, rose bengal) as the sensitizer is readily polymerized on irradiation with visible light if oxygen is present and if the solution contains a mild reducing agent. Ascorbic acid and phenylhydrazine hydrochloride are particularly effective as reducing agents, while the photopolymerization proceeds more slowly with hydroxylamine,

hydrazine sulphate, thiourea, allylthiourea, glutathione and cysteine. In the absence of oxygen, the dye is photoreduced to its leuco form with a quantum yield of about 10^{-3} , but no polymer is produced. It appears that in the presence of air, the reduced form of the dye, DH_2 , reacts with atmospheric oxygen to produce the semiquinone form of the dye DH and hydroxyl radicals, that is, $DH_2 + \frac{1}{2}O_2 \rightarrow DH + OH$. The free radicals thus produced initiate the polymerization of the monomer.

Pure liquid monomers and concentrated solutions of monomers in either water, methanol or acetone were also found to be rapidly photopolymerized when certain combinations of dye-reducing agents were present. Thus, liquid acrylonitrile is readily photopolymerized when acriflavine is used as the photosensitizer in conjunction with a small amount (10^{-4} per cent) of freshly prepared acidified stannous chloride. This reaction does not proceed in the absence of oxygen. Liquid styrene is photopolymerized when a small amount of an alcoholic mixture of rose bengal and phenylhydrazine hydrochloride is added to the system. Other monomers which have been photopolymerized by these methods include acrylic acid, methacrylic acid, vinyl acetate, and methyl methacrylate. Some dyes such as brilliant green and rhodamine B were found to be effective, whereas other dyes, such as all the triphenyl methane dyes which we tested, were found to be ineffectual. Azine dyes, particularly pinakryptol green, in trace amounts (10^{-4} per cent) are inhibitors of photopolymerization for the systems described above. It is significant that the azine dyes are also inhibitors for the photoreduction of fluorescein and its halogenated derivatives^{6,7}.

The choice of the reducing agent to be used in conjunction with a given dye is critical. In general, the reduction potentials of the dye (at a given pH) should be more negative than that of the reducing agent, so that the dye is not decolorized in the dark. Furthermore, the reduction potential of the dye should be within about two electron volts of that of the reducing agents, since this is a necessary condition for the photoreduction of the dye by visible light⁸. The concentration of oxygen present is also critical. Oxygen can participate in the photosensitized destruction of the reducing agent and will, for some monomers, inhibit the growth of the polymer chain. Uri⁹ found that the quantum yield for photopolymerization of methyl methacrylate in alcohol sensitized with chlorophyll was considerably enhanced if ascorbic acid is present; but the reaction does not proceed in the presence of oxygen. In some cases it appears that the solvent, for example, acetone, may participate in the reaction and that the semiquinone form of the dye is the active radical for the initiation of the polymerization.

Certain monomers such as N-vinyl pyrrolidone and acrylamide are themselves reducing agents. For example, aqueous solutions of acrylamide sensitized with the easily reducible dye riboflavin are readily photosensitized, no additional reducing agent being added. A 10 per cent aqueous solution of acrylamide containing 0.005 per cent riboflavin was irradiated with light from a 500-W. tungsten lamp, the sample being 45 in. from the lamp, and a blue Corning glass filter passing light mainly of wave-length 4360 Å. was interposed between the lamp and the solution. By the use of a calibrated thermopile, it was determined that 2.8×10^{-10} einsteins were absorbed by 1 ml. of the solution per sec. After an induction

period of 5 min., the monomer is converted into polymer at a constant rate and the viscosity rises very sharply, the solution becoming a stiff gel after irradiation for 30 min. The quantum yield of monomer conversion is 4,250. Much higher quantum yields are obtained using high concentrations of monomer and decreasing somewhat the oxygen concentration, although complete removal of oxygen inhibits the reaction. The molecular weight of the polymer produced after irradiation for 15 min. was found by light scattering (after carefully washing the methanol-precipitated polymer and redissolving in water) to be 8.32 millions. This extraordinarily high molecular weight may be attributed in part to the fact that the polymerization was carried out at room temperature rather than at elevated temperatures where most polymerizations (thermally initiated) are carried out.

A 10 per cent solution of acrylamide sensitized with riboflavin was irradiated with a single burst of light of millisecond duration from a large commercial photographic flash lamp. After an induction period of one hour, the viscosity of the solution gradually rises and the system becomes a stiff gel on standing 24 hr. in the dark. More concentrated solutions of monomer also show an induction period, and the solution is rapidly transformed into a hard, clear plastic. The sample becomes very hot due to the exothermic character of the polymerization. Solutions from which oxygen had been rigorously removed do not exhibit polymerization after irradiation by the flash until the vessel is opened to the atmosphere. It is clear that free radicals are not produced directly by visible light, but rather are produced by the dark reaction between the reduced dye and oxygen.

¹ See, for example, Oster, G., and Mark, H., *J. Opt. Soc. Amer.*, **43**, 283 (1953).

² See, for example, Klatts, F., and Muller, H., U.S. Pat. 1,930,403 (1933). Christ, R. B., *Chem. and Indust.*, **50**, 267 (1940). Burnett, G. M., and Melville, H. W., *Proc. Roy. Soc. A*, **180**, 481 (1947).

³ Owens, J. S., U.S. Pat. 2,344,785 (1944). Barendse, J. H., Evans, M. G., and Park, G. S., *Trans. Faraday Soc.*, **42**, 155 (1946). Evans, M. G., Santappa, M., and Uri, N., *J. Polymer Sci.*, **7**, 243 (1951).

⁴ Bamford, C. H., and Dewar, M. J. S., *Symp. Soc. Dyers and Colourists* (1949), 110. Whyte, B. B., and Melville, H. W., *ibid.*, 119.

⁵ Oster, G., paper presented before the 132nd Annual Meeting of the Amer. Chem. Soc., Atlantic City, September 15, 1953.

⁶ Oster, G., *Photographic Engineering*, **4**, 173 (1953), and forthcoming patent disclosures.

⁷ Oster, G., Adelman, A., Schrader, M., and Wothenspoon, N. (unpublished results).

⁸ Uri, N., *J. Amer. Chem. Soc.*, **74**, 5808 (1952).

VISUAL PURPLE LEVEL AND THE COURSE OF DARK ADAPTATION

By DR. W. A. H. RUSHTON, F.R.S., and R. D. COHEN

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WHEN we go suddenly from moderate light into darkness, at first we can see nothing; but over the next half-hour visibility greatly improves. Owing largely to the work of Hecht, the improvement has been attributed in the main to two factors: (a) the shift of vision from cones to rods; (b) the regeneration of visual purple bleached in the light-adapted state. With regard to (b), there is no doubt that this occurs after intense illumination, for Tanale¹ followed the process in the rat by extracting the visual purple from the eyes of animals killed at various stages, and Rushton² (with Brindley and Hagins) has measured the course of bleaching and regeneration

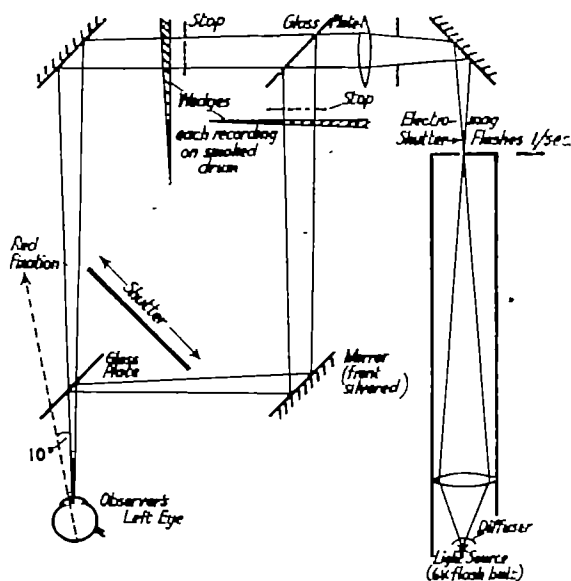


Fig. 1. Adaptometer with alternate light-paths so that two different test flashes may be compared throughout dark adaptation

in the living cat and albino rabbit by an optical method. But as Granit *et al.*³ have shown, there is a very serious discrepancy in the quantitative correspondence between the change of visibility and the change in visual purple content of the retina; for, light of a brightness which would alter the visibility many hundred-fold (as indicated in the animal by change in the size of the electroretinogram) was found not to have appreciably bleached the visual purple, later extracted and measured. Schouten and Ornstein⁴ demonstrated that the effect of glare cannot be explained upon a pure photochemical basis, and Baumgardt⁵ has calculated that at moderate illumination extremely little of the visual purple supply of the eye would be broken down. Our own observations have led us in the same direction, and from the evidence now to be presented we conclude that there is no detectable change in the level of visual purple in the hundred-fold increase of sensitivity which follows the extinction of an ordinary room light.

The observer himself plotted the course of his dark adaptation by moving a wedge in front of his eye so that a flash of light was only just visible (Fig. 1). The wedge movement was recorded upon a very slow smoked drum. By means of alternate optical pathways from flash to eye, each with its own recording wedges, two dark adaptation curves could be traced at a single run by arranging that the flashes came now by one path, now by the other. In this way the effects of colour, field-size, duration and retinal location of the flash could be easily compared at a given stage of adaptation. A red fixation point was used and the flashes fell at about 1 per sec., some 10° on the temporal aspect of the retina (that is, far from the blind spot). The observer first spent half an hour in the dark, then he had 20 sec. close in front of an opal glass of luminance 300 ft. L. for light adaptation; the adaptation curves were then traced in the dark by setting the wedges alternately.

The results of one typical experiment are shown in Fig. 2; they were adjusted to coincide for full dark adaptation. The test flash was green; but the same results are obtained with any colour from

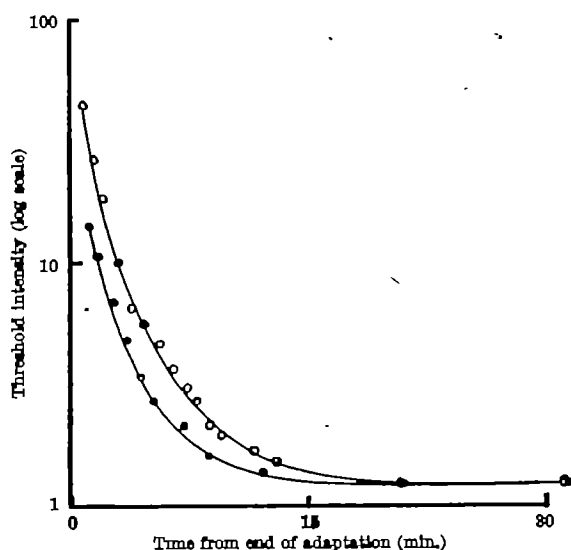


Fig. 2. Threshold intensity of a just visible flash plotted against time from end of light adaptation (300 ft. L. for 20 sec.). Circles: 3° field, 1 sec. flash. Dots: 3° field, 7 msec. flash. Adjusted to coincide at full adaptation

violet to yellow-green. Orange and red, on the other hand, give an adaptation which is rapid and slight, due no doubt to cones being involved. We conclude that the curves of Fig. 2 are entirely due to rods.

Now the regeneration of visual purple must affect these two curves equally; hence the superior dark adaptation of the upper one is clearly due to other causes. But we can exclude regeneration as a cause even of the lower one. For if we assume that visual purple in the eye bleaches as it does in solution with a quantum efficiency of 1 (Dartnall *et al.*)⁴, then 20 sec. at 300 ft. L. with pupil diameter 3 mm. will bleach about 2 per cent of the visual purple present. It is not easy to escape this conclusion by supposing that in the living eye visual purple is bleached much faster than *in vitro*, for (unpublished) observations by Rushton and Hagns on the living albino rabbit show the bleaching-rate to be about the same as in solution (or a little slower). Thus in the experiment of Fig. 2, the visual purple could not increase its concentration appreciably throughout dark adaptation since at the outset it was 98 per cent of the maximum.

We must therefore turn to consider what factors could account for the increased visibility during dark adaptation which certainly occurred. These may conveniently be classified in four categories: increase in (i) the fraction of light incident upon the cornea which reaches the retina; (ii) the fraction of light incident upon the retina absorbed by the visual purple; (iii) the summation time and summation area; (iv) the quantum sensitivity.

The only likely variable under (i) is size of pupil. This could not affect our records since the light flash was focused upon the centre of the pupil in a 1.2-mm. pencil.

(ii) As we have seen, this effect cannot contribute.

(iii) An optic nerve fibre will only discharge if the receptors connected to it have caught a certain number, N , of quanta within a certain summation time. The longer the summation time and the wider the summation area, the more likely that N quanta will be caught from a flash which is extended in space and time (as in the circles, Fig. 2). But if the

flash were highly restricted in space and time (dots, Fig. 2), no increase in sensitivity would appear from cause (iii). The difference in the curves of Fig. 2 may thus be regarded as expressing the increase in summation area and time which occurs as dark adaptation proceeds, as already found by Craik and Vernon⁵. It is left unsettled whether this is a gradual increase in the size of receptive field of single nerve fibres as found in the cat by Kuffler⁶, or a change of activity from small to large fibres as suggested by Pirenne and Denton⁷. In any event, it is highly efficient, since 'information' is not lost, but by exchanging sensitivity for precision, the maximum discrimination can be secured at each luminance.

(iv) The quantum sensitivity is the inverse of N , the number of quanta necessary to excite an optic nerve fibre. Since the lower curve of Fig. 2 is not affected by (i), (ii) or (iii), it must represent simply a change in (iv) during dark adaptation.

We conclude that, in the conditions here considered, by far the chief factor in dark adaptation is an increase in quantum sensitivity of the retina.

[Nov. 13.

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REPRODUCTION IN MARSUPIALS

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RESEARCH on the problems of marsupial reproduction is at present in progress in this department. Several marsupial species are housed in the departmental enclosures; but so far systematic work, here briefly reported, has been limited to the Rottnest Island wallaby (*Setonix brachyurus* Quoy and Gaimard). This animal breeds readily in captivity, and periodical surveys carried out on Rottnest Island indicate no great differences in reproductive processes between the wild population and the departmental colony. Several papers dealing with aspects of reproduction in this animal are at present in course of preparation.

The reproductive system is anatomically similar to those of other macropod marsupials described by Pearson¹. Our records show that *Setonix* is exclusively monovular; multiple ovulations or births have not been recorded in either wild or captive populations. The animal is polyoestrous, and the recurring oestrous cycles are of approximately twenty-eight days duration. This is the same length as the oestrous cycle in the American polyprotodont marsupial *Didelphis*². In both wild and domestic populations the unfertilized *Setonix* has regular oestrous cycles between late January and the end of October. During the remaining (summer) months there is an aneostrous phase during which ovary and uterus are quiescent.

The significance and cause of the annual aneostrous are not known. Experiments are in progress to

determine whether increased daily illumination is the immediate predetermining stimulus. During the summer, the animal is exposed to periods of extreme drought, and it could be plausibly postulated that the anoestrous period has adaptive significance in preventing the extra water utilization involved in lactation during the dry period. It also has the merit of ensuring that most births take place immediately after anoestrus, the young then being sufficiently developed to leave the pouch when green feed is abundant in the following spring.

We have little information concerning the number and length of the oestrous cycles in other marsupials. Hartman² showed *Didelphis* to be polyoestrous, whereas Hill and O'Donoghue³ consider the Australian polyprotodont, *Dasyurus viverrinus*, to be monoestrous. *Bettongia orniculatus* is polyoestrous, the length of the cycle being unknown, although there may be an anoestrous period in the summer months⁴.

In wild populations of *Setonix* there is a burst of sexual activity following the annual anoestrous period, and it is at this time that the majority of young are born. Copulation takes place while the first maturation division is proceeding in the ovarian egg. Ovulation follows in mated animals approximately one day post-coitum. In unmated animals ovulation is independent of the stimulus of copulation. Parturition occurs from twenty-four to twenty-eight days after mating, most likely on day twenty-six or twenty-seven. As in the American opossum, gestation is thus shorter than the length of a normal oestrous cycle. In *Didelphis*, as in *Setonix* and most other Australian marsupials, no true allantoic placenta exists at any time during gestation. It is probable that the marsupial yolk-sac placenta, unlike the eutherian (allantoic) placenta, has not assumed pituitary and ovarian functions as a secondary source of hormones. If this is true, it may well mean that the aplacental marsupials are physiologically incapable of retaining young in the uterus for a period greater than the length of the oestrous cycle.

In fertilized animals, maturation of an ovarian follicle continues during pregnancy as in the normal non-pregnant animal. Parturition is closely followed by oestrus and ovulation, the corpus luteum of post-partum ovulation becoming the corpus luteum of lactation. This corpus luteum is maintained during the ensuing five or six months, while the young is suckled in the pouch, and retrogresses thereafter. During at least the first half of this time a lactation anoestrus occurs. Although females normally copulate at post-partum ovulation, birth of a second young does not occur while the mother is feeding an embryo in the pouch. However, females segregated from males immediately after post-parturition copulation give birth to a second young if lactation is interrupted by removal of the pouch young. This second foetus could be explained either by delayed implantation or by the prolonged storage of sperm. Delayed implantation in rodents is known to be due to the feeding of large litters by the pregnant mother. Although the uteri of lactating *Setonix* present no external differences from those of the non-pregnant animal, these were subjected to thorough search in serial section. In several lactating animals which had copulated at post-partum heat a small unimplanted blastocyst 0.3 mm. in diameter was found in the uterus; blastocysts have also been recovered whole by flushing the uterus with saline.

The unimplanted blastocysts of lactating *Setonix* can certainly proceed to normal development after a quiescent period of four months; some evidence indicates that they may remain viable for periods of about eight months in this state of suspended animation. It appears, therefore, that we have a sufficient explanation of delayed parturition in terms of 'stored unimplanted blastocysts'. As an additional confirmation of this conclusion, we destroyed the Fallopian tubes in two females suckling pouch young, so that no new eggs could enter the tract. The suckling young were removed from both. Two days later, the uterus of one mother was flushed out and a small blastocyst recovered. Eleven days after the operation the uterus of the second mother was similarly treated, and a large actively dividing embryo recovered.

In all Eutheria investigated, with the possible exception of the bat⁵, sperm may have a very short life in the female tract. So it would be surprising if storage of sperm in the marsupial female tract were a reason for delayed parturition. At best, of course, it could only be a cause supplementary to the delayed implantation described above. Nevertheless, careful search was made for sperm in the female tract, and although easy enough to find immediately after copulation, they were never detected at a greater period than a week after insemination.

It is not known how widespread the phenomenon of delayed parturition is in marsupials, although many (often verbal) reports are known. A case is cited by Wood Jones⁶ in which a female red kangaroo suckled a pouch young for about a year after the death of the male parent. This female, in captivity in Philadelphia Zoo, could not possibly have mated after the death of the male kangaroo, yet gave birth to another young at about the time the pouch-life of the first young ended. In this, as in other cases of delayed parturition in marsupials, it is interesting to note that the female was lactating during the delayed period. Flynn⁴ recorded several specimens of the macropod marsupial *Bettongia orniculatus* carrying pouch young of widely different ages to have a small blastocyst in one or other uterus. Limited by lack of controlled breeding experiments, he concluded these blastocysts to be stages in normal pregnancy. He was therefore forced to suggest a very short (six weeks) pouch-life of the embryo, since only one young occupies the pouch at one time. In all other macropod marsupials for which information is available, the pouch-life exceeds four months.

I am indebted to Prof. H. Waring for assistance in the field and with surgery, to Mr. A. J. Fraser for making sea transport available and in his capacity of chief warden of fauna in Western Australia, to Miss Nathan for general and histological assistance, and to Mr. Jeapes for animal maintenance. The animal compounds were paid for from an Australian Commonwealth Research grant which also met some of the expenses.

The work reported is part of a programme on marsupial biology under the general direction of Prof. Waring and financed by a grant from the Nuffield Foundation. [Aug. 9.]

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Fluorine in Tea and Caries in Rats

FLUORIDATION of communal water supplies is expanding rapidly in the United States, and it has been recommended that water supplies in Britain should also be treated¹. Nevertheless, it is generally recognized that Britons already take appreciable amounts of fluorine in their tea, which is rich in this element. Experiments detailed in this communication deal with the effect of tea infusion on dental caries in the rat.

Litter-mate Wistar rats 23 days of age were used in these experiments, which were continued for sixteen consecutive weeks. The cariogenic diets comprised 800 gm. cracked yellow corn, 30 gm. alfalfa meal, 60 gm. linseed meal, 250 gm. sucrose, 80 gm. corn oil, 50 gm. active dry yeast and 10 gm. sodium chloride; 1 gm. fresh liver was added to this diet once weekly. In the control group, water with 0.02 p.p.m. of fluorine was allowed *ad libitum*. In the experimental group, similar water was used to make strong infusions of a commercial brand of tea (Standard Brands Instant Tenderleaf Tea (orange pekoe and pekoe black)). Such infusions, checked for fluorine concentration by the method of McClelland and Foster², would be considered too strong for humans, who are much more sensitive to fluorine than rats as measured by dental fluorosis. The small content of dextrimaltose in the tea was duplicated in the drinking water of the controls. Repeated periodical comparisons proved that those rats allowed only tea infusions consumed quantities similar to those drinking water. At the end of the experimental period, the animals were weighed and X-ray examinations were made of the skeleton and jaw bones for comparison of calcification and dental caries.

Slightly more than half the original thirty animals in each group were dead at the end of the experiment, leaving eleven pairs of litter-mates for final examination.

Animals in both groups failed to gain weight normally. X-ray examinations showed the skeleton in both groups to be similarly decalcified. Caries of the lower molars with much alveoloclasis was present in both groups with no significant difference (Table 1 and Figs. 1-4).

If fluorine in a concentration of 1 p.p.m. in drinking water is optimum for human consumption as now generally conceded, then it might be expected that strong tea infusions containing 20 p.p.m. of fluorine and taken in large quantities would have some abnormal effect on skeletal calcification. It is recognized that 85 per cent of fluor-

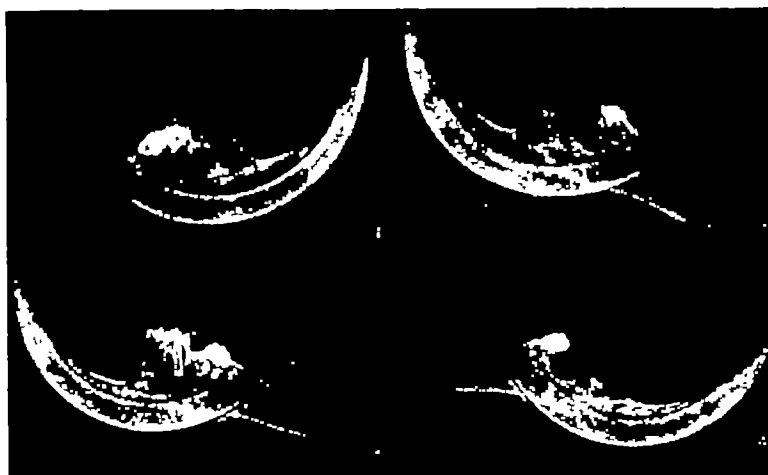
Table 1. EFFECT OF TEA INFUSION ON DENTAL CARIES OF THE RAT

	No. of rats	No. of carious molars	Average wt. at 23 days (gm.)	Average wt. at 185 days (gm.)	Remarks
Control	11	37	83.0	182	Moderate alveoloclasis and skeletal osteoporosis
Tea infusion (20 p.p.m. fluorine)	11	32	84.7	189	Osteoporosis and alveoloclasis similar to controls

ine in dry tea may go into an infusion; but ordinarily brews may contain only 1 p.p.m. of fluorine due to the use of only small amounts of the dried leaf. This may explain the analysis of rib bones among residents of London, England, made by Glock, Lowater and Murray³, who found no greater concentration of fluorine than that found by similar studies in other parts of the world.

The resemblance of dental caries in the rat to that of humans following the consumption of large quantities of tea may be only a coincidence. In order to produce good bone calcification and cario-stasis in the rat, we previously found it necessary to use more than 350 p.p.m. of fluorine, optimum results being obtained with 700 p.p.m. of fluorine when given in the form of Tennessee brown rock phosphate⁴. But there are reports like that of McClure and Mitchell in which as little as 10 p.p.m. of fluorine in the diet of rats was found to have some cario-static effect⁵.

Possibly, the high calcium and phosphorus content of the fertilizer used by us influenced the action of fluorine in the cario-static diets. In humans, toxic doses of fluorine are said to produce osteosclerosis⁶; but whether this precise effect can be observed with dietary insufficiency of calcium and phosphorus, either in experimental animals or man, has not been established. Besides considering other factors such as solubility and absorbability of fluorine from tea infusions, it will be interesting to observe whether in Great Britain the same good results with fluoridation of communal water supplies can be obtained as in the



(1) and (2). Caries and alveoloclasis in lower jaw of rat on cariogenic-water diet

(3) and (4). Similar changes in lower jaw of a litter-mate rat on cariogenic-tea infusion diet

United States without more attention to dietary calcium and phosphorus.

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Fluorine Content of some Nigerian Waters

FLUORINE absorption from drinking water during the period of calcification of the teeth has long been correlated with mottling of the dental enamel¹. In East Africa the excessive amounts of fluorine in some drinking waters have become a matter for urgent consideration²; but little is known of fluorine distribution in West African waters.

The surface rocks of Nigeria consist of two large areas of granites separated by marine sediments in the Niger and Benue valleys; Tertiary sediments occur in the north-east in the Lake Chad drainage basin.

On the Central Plateau, a series of Younger granites are known to have a high fluorine content which does not, except in very small amounts, break down into compounds soluble in water; fairly extensive parts of these granites are covered by basaltic lava flows of Tertiary and Recent age. Streams used for drinking-water arise by seepage from below the basalt or by drainage off purely granitic areas. Ten samples of representative Plateau waters were flown to Great Britain for examination; in nine instances the fluorine content was low—between 0.2 and 0.4 parts per million—and in one sample there was no fluorine. A mild degree of dental fluorosis was seen among members of six aboriginal tribes who lived on the Plateau.

Fluorine occurs among the minerals present in the Niger and Benue valleys. A sample of water from the shaft of a lead-zinc lode near Abakaliki contained 3.3 p.p.m. of fluorine; but surface waters in general would contain considerably less: of 65 primary schoolgirls aged seven to fifteen years examined in Niger Province, eight showed mottled dental enamel. Dental fluorosis was seen in the teeth of adults whose homes were in Adamawa, Bauchi, and Bornu Provinces. It is probable that the sources of fluorine in these areas are the crystalline rocks of the basement complex. Six samples of well water from Maiduguri town, in Bornu, had fluorine contents ranging from 0.1 to 1.2 p.p.m., and 15.8 per cent of thirty-eight girls in boarding school had a moderate degree of mottled enamel.

It is concluded that in Nigeria the fluorine compounds present in Pre-Cambrian rocks do not, except in small amounts, become soluble in drinking waters.

Samples of water were obtained for examination with the help of Dr. R. Jacobson, Mr. W. N. MacLeod and Dr. A. M. J. de Swardt, of the Geological Survey of Nigeria. Thanks are due to Prof. Margaret Murray, who undertook the examination of Nigerian waters for their fluorine content.

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Enzymic Iodination of Milk Proteins

RECENTLY, Pitney and Russell Fraser¹ have reported studies in which they utilized, as a model system for antithyroid drug evaluation, a procedure based on that of Keeton² for the enzymic iodination of milk proteins. This has prompted us to outline some of our observations with a similar system using purified milk enzymes and proteins. Native casein in a finely suspensible form was obtained from separated milk by differential high-speed centrifugation at 0°. It was washed with water and freeze-dried from an aqueous dispersion. β -Lactoglobulin was prepared essentially according to Palmer³. In order to obtain lactoperoxidase (of about 40 per cent purity as judged by absorption data) the fraction of milk separating at 50–70 per cent saturation with ammonium sulphate was treated by an unpublished procedure developed by Dr. D. Morell, who also kindly provided a purified specimen of xanthine oxidase⁴.

In order to test their relative reactivity in iodination experiments, the purified proteins (150 mgm.) were shaken and incubated in duplicate for 1 hr. at 37° in 0.05 M phosphate buffer medium at pH 6.8 with added xanthine (600 μ gm.), iodine-131 (usually 50 μ c.) with carrier potassium iodide (15 μ gm.) and the two enzymes (in amounts equivalent to ten times the average contents of milk, based on the casein used), the final volume being approximately 5 ml. The precipitates obtained with 10 per cent trichloroacetic acid were washed twice with 5 per cent trichloroacetic acid, hydrolysed with 2 N sodium hydroxide for 16 hr. at 105°, and the hydrolysates extracted twice with equal volumes of *n*-butanol. The butanol extracts were washed twice with equal volumes of 4 N sodium hydroxide/5 per cent sodium carbonate. Although counts were made on the several fractions, only the radioactivity contents of the washed butanol extracts are given in Table 1 (A). Under these conditions, our best results indicated about 2 per cent binding of iodine in the butanol-soluble ('thyroxine') form by casein. Chromatographic fractionation of both alkaline and enzymic hydrolysates (using purified thyroid protease⁵ as the enzyme) showed that more than 90 per cent of the iodine incorporated was fixed in the form 3-iodotyrosine. The addition of cupric ions and tyrosine as recommended by Weiss⁶ in his iodine-uptake studies using particulate components of thyroid tissue gave no increase in the butanol-soluble fraction (Table 1, D).

Purified β -lactoglobulin exhibited a very weak capacity for binding iodine in butanol-soluble form.

Table 1

	A		B				C		D	
	Cas.	Lg.	Cas.	Lg.	Cas.	Lg.	Cas.	Lg.	Cas.	Cas.
Butanol extract (μ C.)	4.45	2.82	2.14	0.73	1.82	0.99	2.00	1.57	4.00	4.58
After first treatment with alkali (μ C.)	1.80	0.18	0.67	0.04	0.43	0.03	0.59	0.06	1.29	1.33
After second treatment with alkali (μ C.)	1.03	0.03	0.52	0.015	0.37	0.01	0.45	0.03	0.82	0.81
Ratio: Cas./Lg.	34	1	35	1	37	1	15	1	—	—

A. Casein (Cas.) and lactoglobulin (Lg.) each 150 mgm., incubated 1 hr., 37°, under standard conditions and then hydrolysed (see text).

B. General conditions as in A, but Cas. and Lg. mixed prior to, and Cas. and Lg. subsequent to, incubation. Iodinated proteins separated by precipitation at pH 4.6 (Cas.), then with trichloroacetic acid (Lg.), before hydrolysis.

C. General conditions as in A, but with the following additions before incubation: to Lg. 5 ml. milk supernatant, from which casein was removed by high-speed centrifuging; to Cas. 5 ml. phosphate buffer.

D. General conditions as in A, but with addition of cupric ions and tyrosine (each $1.8 \times 10^{-4} M$) to Cas.

Even allowing for its lower tyrosine percentage composition (3.78) than casein (6.1)*, it is much less efficient under the conditions used. In order to ascertain whether the purified casein contained, by contrast, an activator of the reaction, equal amounts of β -lactoglobulin and casein test solutions were mixed immediately before, and following, the incubation period, and the solutions then fractionally precipitated (casein at pH 4.6, β -lactoglobulin with trichloroacetic acid). Table 1, B shows that the results were comparable. To examine this point further, the supernatant of milk (5 ml.), from which the casein had been removed by prolonged high-speed centrifugation, was added to a β -lactoglobulin test solution prior to incubation. It is possible that the apparently slight favourable effect (decrease in the ratio casein to lactoglobulin) observed (Table 1, C) may have been due to traces of casein in the milk supernatant added.

From our overall results it seems that the tyrosine residues in β -lactoglobulin are not as favourably situated for conjugation to the iodinated thyronines as are those in casein, and that, in the iodination of

milk, casein would be almost entirely responsible for the butanol-soluble fraction.

Keston⁸ showed that thiourea is an effective inhibitor of the uptake of iodine by the proteins of milk, similar findings being obtained by Pitney and Russell Fraser¹ for both 2-thiouracil and resorcinol in the enzymic iodination of casein. However, the latter authors failed to prevent iodination of casein with thiouracil, in contrast to resorcinol (60 per cent inhibition), under enzyme-free conditions in which the conversion of iodide to iodine was brought about by incorporating dilute hydrogen peroxide in the medium. They therefore conclude that such anti-thyroid drugs do not act by removal of available free iodine⁹. However, the failure of thiouracil to inhibit in the 'chemical' system could be due to its greater sensitivity towards dilute peroxide than resorcinol. In fact, we have shown that thiouracil, unlike resorcinol, is completely changed by added peroxide under conditions comparable to those used by the authors mentioned, whereas it survives to a large extent when the peroxide is produced enzymically.

Solutions of thiouracil ($10^{-3} M$; 100 ml.) with and without hydrogen peroxide ($10^{-3} M$) were incubated for 45 min. at 37° and then frozen and dried in this condition. The residues were dissolved in warm *n*-butanol (saturated with water), applied to paper and run in *n*-butanol/water (16 hr.). As can be seen from the photograph of the chromatogram taken with ultra-violet light¹⁰ the thiouracil spot has shifted as the result of peroxide treatment (Fig. 1, A). Spraying the paper with Chargaff's reagent (iodine and sodium azide) produced an immediate reaction with the control spot, whereas the other reacted only weakly after some minutes. Such differentiation is similar to that observed with cysteine and cystine respectively¹¹. The chromatogram (*n*-butanol/acetic/water¹²; Ehrlich reagent spray¹³) obtained after resorcinol had been treated under identical conditions is illustrated in Fig. 1, C. The control and treated spots are comparable in appearance and position; this was also the case when the chromatogram was run in *n*-butanol/ammonia.

The effect on thiouracil of peroxide produced enzymically was tested by incubating, for 45 min. at 37°, a solution of thiouracil ($10^{-3} M$; 100 ml.) containing xanthine (4.5 mgm.) and excess lactoperoxidase and xanthine oxidase, so that the system gave a strong positive reaction with Nadi reagent. Xanthine was omitted from the control. The incubated solutions were then treated as for the chemical system. As can be seen from Fig. 1, B, a major proportion of the thiouracil remains unchanged under these conditions.



Fig. 1. Chromatograms of peroxide-treated anti-thyroid drugs. A. (i) Thiouracil ($10^{-3} M$) incubated for 45 min. at 37° with hydrogen peroxide ($10^{-3} M$). (ii) Thiouracil control—no peroxide added. Solvent system *n*-butanol/water.

B. (i) Thiouracil control—no xanthine added. (ii) Thiouracil ($10^{-3} M$) incubated for 45 min. at 37° with xanthine and excess xanthine oxidase and lactoperoxidase. Note trace of oxidation product at lower R_F. Solvent system *n*-butanol/water.

C. (i) Resorcinol ($10^{-3} M$) incubated for 45 min. at 37° with hydrogen peroxide ($10^{-3} M$). (ii) Resorcinol control—no peroxide added. Solvent system *n*-butanol/acetic/water.

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Induction of Ovarian Tumours with 9 : 10-Dimethyl-1 : 2-Benzanthracene

MAMMARY carcinoma can be readily induced in certain strains of mice by treatment with 20-methylcholanthrene. In the course of experiments intended to investigate whether other members of the same group of carcinogenic hydrocarbons are also effective on the breast, an incidental finding has been made that treatment with 9 : 10-dimethyl-1 : 2-benzanthracene leads to the appearance of ovarian tumours.

Female mice of the Bonser *IF* strain were treated with 0.5 per cent 9 : 10-dimethyl-1 : 2-benzanthracene in olive oil by the technique previously described¹. After a small pilot series to determine dosage, the first batch consisted of thirty animals, of which eight other mice survived when the first ovarian tumour was observed after 238 days; of these, one further mouse revealed a macroscopic ovarian tumour and others showed microscopical abnormalities. In a second series of twenty-nine animals, the first ovarian tumour was found at 196 days, when there were twenty-two survivors. Of these, nine were afterwards found to have macroscopic ovarian tumours, and four showed early tumours histologically. Of the total thirty-one mice 'at risk', there were therefore macroscopic tumours in eleven (35 per cent), and the total tumours found were fifteen (48 per cent).

The macroscopic tumours were 0.5-1 cm. in diameter, bright yellow in colour and sometimes haemorrhagic. Histologically, they were all of obviously granulosa-celled origin. Apart from the tumours, all the ovaries of mice surviving to tumour age showed histological abnormalities. One of the tumours has been successfully transplanted. It retains its histological differentiation. Some at least of the tumours appear to function oestrogenically, as estimated by vaginal smears; the non-tumour-bearing animals tested have, on the other hand, been in continuous di-oestrus. Most of the animals, including all those with ovarian tumours, have also showed breast carcinomata. There is a suggestion

that the average number of breasts affected is greater in the ovarian-tumour mice than in the others.

Ovarian tumours have not been obtained in C57 black mice with 9 : 10-dimethyl-1 : 2-benzanthracene. It has been confirmed by *ad hoc* experimentation that methylcholanthrene does not give ovarian tumours in the *IF* strain, and does not lead to histological abnormalities of the extent found following dimethyl-benzanthracene treatment.

Further work is in progress before the results are published in detail, but we feel justified at this stage in directing attention to what must be regarded as an important qualitative difference in the biological action of two carcinogens belonging to the same general group of cyclic hydrocarbons.

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Influence of the Thyroid upon the Survival-Rate of Guinea Pigs treated with X-Rays

It has been shown that the lesions of the thymus induced by X-rays are restored more quickly in thyroidectomized guinea pigs than in normal animals. This supported the supposition that (to a certain extent) disorders induced by X-rays may be dependent upon the thyroid.

The influence of X-ray irradiation upon the thyroid is still under discussion¹. This is understandable, since it can be shown that lethal irradiation does not induce any sign of thyroid stimulation in rats, whereas signs of thyroid stimulation are observed after a non-lethal dose of radiation².

A total of 46 male guinea pigs of average weight 200 ± 15 gm. were irradiated and divided into three groups: (1) 15 thyroidectomized animals; (2) 16 thyroidectomized animals, which received every second day injections of 6 γ thyroxin per 100 gm. (this is sufficient to prevent the thymus atrophy determined by thyroid extirpation³); (3) 15 normal controls.

The animals were irradiated under the following conditions: one single total irradiation of 800 r., given with a Siemens-Halske apparatus, 160 kV., 10 mamp., target distance 50 cm., field 20 cm. $\times$ 24 cm., 1 mm. copper filter. Thyroidectomized animals were irradiated fifteen days after the operation. The survival-rate of these animals is shown in Table 1.

Table 1. SURVIVAL-RATE OF GUINEA PIGS FOLLOWING A SINGLE TOTAL X-RAY IRRADIATION OF 800 R.

Days after irradiation	Survival-rate		
	Normal	Thyroid-ectomized	Thyroidectomized and injected with thyroxin (6 γ per 100 gm. and 48 hr.)
0	15	15	16
8	15	15	16
9	13	14	15
10	11	10	13
11	8	8	8
12	6	5	6
13	5	4	5
14	4	4	4
15	3	3	3
16	3	3	3
20	3	3	3

It is obvious that thyroidectomy has not shown any influence upon the resistance of guinea pigs to X-rays. The survival curve in thyroidectomized guinea pigs is almost the same as in normal animals. This was also confirmed in thyroidectomized animals injected with thyroxin in physiological amounts.

This result seems to be in contradiction to the previous observations, from which it was concluded that lesions of the thymus induced by X-rays may be to a certain extent the expression of thyroid stimulation occurring in these conditions. In spite of this, thyroid stimulation is observed after non-lethal irradiation only¹. It seems, therefore, that there is an upper limit to thyroid stimulation. Certainly, the part played by the thyroid in disorders induced by X-rays can be considered as slight.

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¹ See bibliography on morphology of the thyroid in X-ray-treated animals in Comra, J., *Ann. Endocrin.*, 13, 231 (1953).

² Bots, H. G., *C.R. Soc. Biol., Paris*, 146, 215 (1952).

³ Comra, J., *Ann. Endocrin.*, 13, 230 (1952).

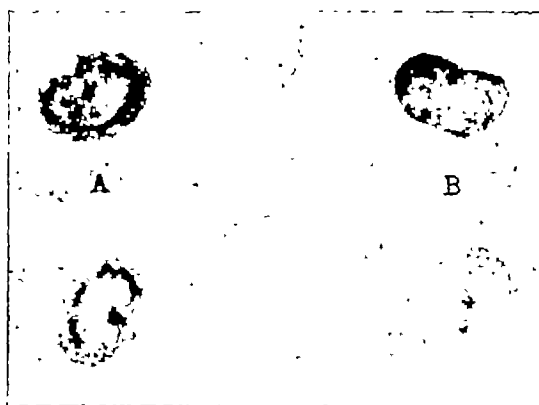
Histochemographical Effect in Rat Kidneys

In 1949, Boyd and Board¹ showed that tissue specimens placed in contact with the emulsion of a photographic plate stored in the dark affected the emulsion in such a way that images of the specimens were obtained following development and fixing. These images, due to chemical action of the specimen on the emulsion, were termed histochemographs.

Histochemographs of various tissues from normal and tumour-bearing albino rats (14 day-old transplants of dibenzanthracene sarcoma (Rd/3), Walker carcinoma and a 20-methylcholanthrene-induced tumour) have now been compared. The transplant animals were obtained from the University of Sheffield Field Laboratories and, in the first experiments, normal rats from the University of Sheffield Animal House were used. Blood, spleen, pancreas and liver preparations from these groups did not differ markedly; but a striking difference appeared in kidney histochemographs prepared as follows.

Rats under ether anaesthesia were sacrificed by exsanguination (aorta severed). Without delay, the kidneys were removed, sliced longitudinally and the halves blotted with Whatman No. 50 filter paper. The halves were placed (cut-side downwards) on the emulsion side of Ilford photographic paper (Contact; 03.1P; single weight; hard glossy) and the preparation mounted on a 'Pliofilm'-covered cork mat under 'Wratten Red Safelight' in a dark room. The preparation (generally kidneys from three normal and three tumour animals were compared simultaneously) was stored in a light-tight box at -15°C . for 50 hr. Then the film was washed for 3 min. in running water to remove tissues, developed five minutes in Kodak document developer at 20°C ., washed and fixed.

As illustrated by the accompanying photograph, prepared from an original histochemograph by printing on Kodak Autopositive Document Paper, kidney preparations from thirteen tumour animals each showed a marked brown crescent (A) in the cortex-



medulla zone. This effect was absent in the kidneys of all but two of fifteen normal rats which gave more or less uniform pale grey histochemographs (B). However, when the kidneys of normal rats from the University Field Laboratory stock were examined, a high proportion of these were found to give the brown crescent reaction (see table). Thus the brown crescent reaction could not be attributed to the presence of a tumour as was at first supposed.

Animals	Brown crescent reaction	
	+	-
17 tumour rats (Univ. Field Lab.)	13	4
17 normal rats (Univ. Field Lab.)	14	3
15 normal rats (Univ. Animal House)	2	13

Rats from the University Field Laboratory are of the Wistar strain bred there. They are maintained on bread and milk (no water) with supplements of horse meat and cod liver oil separately every second and third day. On the other hand, rats from the University Animal House were obtained or bred from Wistar strains received from dealers. These animals were maintained on commercial rat cubes (Edinburgh Rat Cube No. 86). It has not been possible to examine completely the effect of diets on the kidney reaction; but some tumour animals maintained for several days on Diet No. 86 and water still gave the brown crescent reaction. The histochemographical effect was found in both male and female tumour and normal rats.

Perhaps we are dealing with a strain difference or with the effect of a disease prevalent in the Field Laboratory animals. Sections from kidneys which gave a positive reaction were not histologically abnormal, and no amyloid could be detected in them. The substance responsible for the brown crescent reaction appears to be susceptible to decomposition or to be readily diffusible, since kidneys which have given a positive reaction are no longer capable of producing the effect after 50 hr. exposure.

Thanks are due to Mr. O. Thornburn of the University of Sheffield Field Laboratories for supplying the tumour animals, to Dr. H. E. Harding for examining the histological preparations, and to Prof. H. N. Green for his interest. The work was supported by a grant from the British Empire Cancer Campaign.

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¹ Boyd, G. A., and Board, F. A., *Science*, 110, 586 (1949).

High Resolution Electron Micrographs of Thin Tissue Sections

Using a method described elsewhere¹, we have been able to cut serial sections of about 250 Å. thickness, and, by varying the speed of cutting successive sections, serial sections of thickness alternately about 350 Å. and 150 Å. There were always thin and thick areas within individual sections. On the basis of the general rule suggested by Cozzetti², that the optimum resolution obtainable from a section is of the order of one-tenth of the thickness, the thinner parts of the 150 Å. sections should afford resolutions of 10 Å. We have succeeded in obtaining such resolutions, as illustrated in Fig. 1.

The specimen is a section of a C3H mouse breast tumour; an intracellular 'double membrane' is clearly visible across the centre of the picture. Comparison of the detail observed with the 100 Å. scale shows that resolutions of 10 Å. have been obtained.

It is clearly necessary to avoid mistaking photographic grain for fine detail. For this reason, the following controls were used. First, the negatives and prints at all stages were submitted to several of the leading photographers here. All were of the opinion, without any doubt, that the detail observed did not represent photographic grain. Secondly, a negative similar so far as possible and particularly in emulsion, development, etc. (actually the next field on the same plate), to the one shown here, but electronically slightly out of focus, was put through a similar process of enlargement; sharp optical focusing was obtained by the use of a small scratch in the emulsion. In such a print no sign of detail



C3H mouse breast tumour. Intracellular 'double membrane' (1) in focus; (2) out of focus

is visible (Fig. 2), indicating that the structure shown in Fig. 1 represents neither photographic grain nor an artefact due to electron scattering in the emulsion.

While resolution of this order is thus shown to be attainable in electron micrographs of sections of animal tissues, at present it can only be attained with selected fields.

Thanks are due to Mr. J. B. Kirkham, of the Department of Experimental Pathology and Cancer Research, for the photographic enlargements.

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Eaves, G. Ph.D. thesis, University of Leeds (1953). Eaves, G., and Flewett, T. H., *Exp. Cell Res.* (in the press).
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Fructose in the Foetal Fluids of Deer

The foetal fluids of a number of species have been examined recently for the presence of free fructose¹. This study has now been extended to the examination of the foetal fluids of three species of deer. The fluids were obtained after pregnant does had been shot. Protein-free filtrates of the fluids were prepared by the barium-zinc method of Somogyi². Total reducing substances were determined by the method of Nelson³, and fructose by a modification of the Seliwanoff method due to Cole (as described by Bacon and Bell⁴).

Fructose was shown to be present in both the allantoic and amniotic fluids of three roe deer (*Capreolus capreolus*), one Père David's deer (*Elaphurus davidianus*) and many specimens of fallow deer (*Dama dama*). The fructose concentrations were usually within the range 100–300 mgm. per cent, and accounted for a large proportion of the total reducing substances. The concentrations of both total reducing substances and fructose were invariably higher in the allantoic than the amniotic fluid. The non-fructose reducing substances consisted mainly of glucose.

Sufficient specimens of foetal fluids of fallow deer became available for a study of the variation of the sugar concentrations with foetal age. Fig. 1 shows the variation of total reducing substances and of fructose in the allantoic fluids and of total reducing substances in the amniotic fluids with foetal crown-

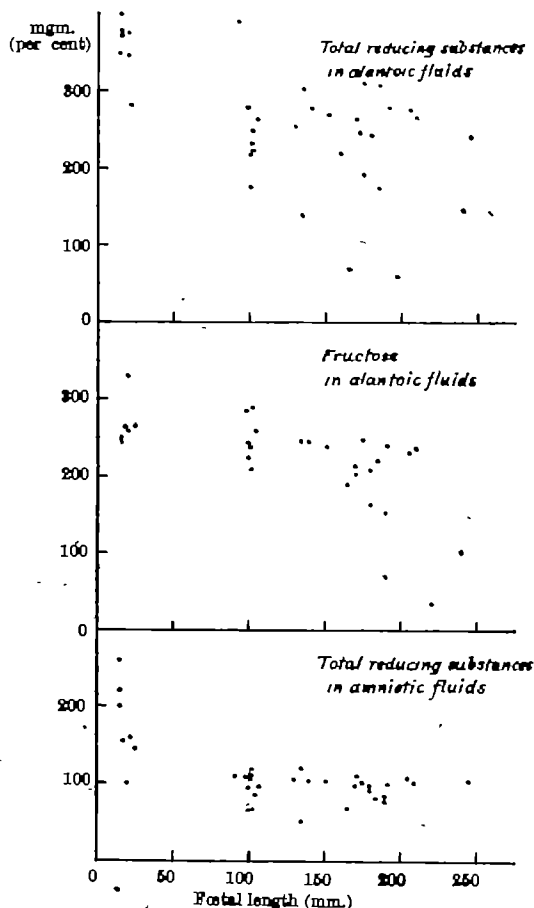


Fig. 1

rump length. Fructose is the major constituent of the amniotic total reducing substances. The foetal ages extend over the period 80-130 days (gestation period approximately 230 days). Unfortunately, no specimens of foetal fluids were available from near-term fetuses.

The results lead to the following conclusions. The concentrations of both fructose and glucose in the allantoic fluid were higher than in the respective amniotic fluid. High concentrations of the sugars in both fluids occurred at a very early stage of pregnancy, and lower values were recorded as the foetal length increased. These results must be considered together with the fact that the volumes of the foetal fluids increase during pregnancy*. The results reported here show greater consistency and a somewhat different type of behaviour from those recorded on the foetal fluids of sheep*. It has not been possible, as yet, to compare the composition of the foetal fluids with that of foetal blood.

I am grateful to Dr. R. J. Harrison, of the Department of Anatomy, who supplied the specimens of foetal fluids, to Prof. F. L. Warren for advice, and to the Sir Halley Stewart Trustees for a grant.

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* Ainsworth, I. B., Ph.D. thesis, University of London (1953).

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Detection of the Sex of Cat Embryos from Nuclear Morphology in the Embryonic Membrane

A sex difference in the morphology of intermitotic nuclei has been described in the nervous system¹ and various tissues and organs of the mature cat². Nuclei of females contain a special mass of chromatin, the sex chromatin, which is seldom seen in nuclei of males. Evidence available so far suggests that the sex chromatin of females represents heterochromatic portions of the two X chromosomes.

It has been found that the sex of cat embryos can be detected by examining nuclei in whole mounts of the embryonic membranes. In addition to the theoretical interest of this observation, the method may prove useful in studies which require a decision as to the sex of embryos before the genitalia have developed distinctive sex characteristics.

The embryonic membrane (fused amnion and allantois) was studied in thirty-nine embryos from ten litters of 19-50 days gestation. The membrane was fixed in a

formol-acetic-alcohol mixture for 24 hr. and in 70 per cent alcohol for a further 24 hr. Small pieces were removed from thin parts of the membrane between blood vessels, and placed in distilled water in watch-glasses. Separate pieces of embryonic membrane from each embryo were stained with Harris's hematoxylin and cresyl echt violet, the solutions being changed with a pipette. The stained preparations were transferred to a microscope slide, cleared with xylol, mounted in piccolyte, and studied with the oil-immersion objective.

Nineteen of the thirty-nine embryos were sufficiently mature to permit identification of sex by examination of the external genitalia; eleven were females and eight were males. The nuclei of the amnion and allantois had the following characteristics in these nineteen embryos: 96-98 per cent of the nuclei in females showed a mass of chromatin, plano-convex in shape, lying at the nuclear membrane (Fig. 1). A similar, although smaller, mass of chromatin was seen in only 7-12 per cent of nuclei in the embryonic membrane of male embryos (Fig. 2). The special mass of chromatin which is characterized by a size relation to sex is the sex chromatin, as described earlier in tissues of adult cats³.

Twenty embryos were in an earlier stage of development, prior to differentiation of the external genitalia. Nuclei of the amnion and allantois showed a typical female morphology in eleven embryos, the sex chromatin being identified in 96-100 per cent of nuclei. The morphology of the nuclei was typically male in the other nine embryos, with a small mass which might be interpreted as sex chromatin visible in 8-9 per cent of nuclei. It is inferred that these two groups of early embryos were female and male, respectively.

Nuclear morphology within the embryo was similar to that of the embryonic membrane. A detailed account of the sex difference in the morphology of the nucleus in embryonic tissues is in preparation.

It is possible that a sex difference in the intermitotic nuclei of amnion and allantois, and in embryonic tissues generally, may occur in those animals which have a sex difference in the nuclei of mature nerve cells⁴, although embryos of species other than the cat have yet to be studied from this point of view.

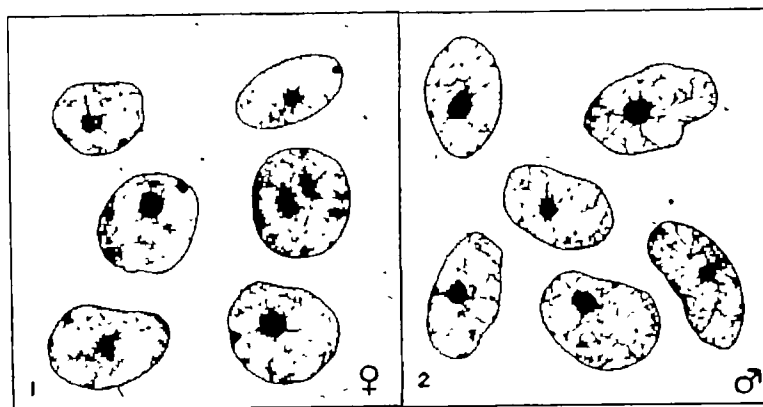


Fig. 1. Nuclei in the embryonic membrane of a female cat embryo. They contain a mass of sex chromatin which lies at the nuclear membrane in most instances.

Fig. 2. Nuclei in the embryonic membrane of a male cat embryo. A chromatin mass, comparable in size, shape and position with the sex chromatin of the female, is seldom seen in male nuclei.

This work was made possible by a grant-in-aid from the National Research Council of Canada.

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¹ Barr, M. L., and Bortram, H. G., *Nature*, 163, 676 (1949). Barr, M. L., Bortram, L. F., and Landmy, H. A., *Anal. Rec.*, 107, 283 (1950). Barr, M. L., *Exp. Cell Res.*, 2, 288 (1951).

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Influence of Position of Truss on Pleiocotyly in Tomato

LEWIS¹ has shown that position of truss affects the manifestation of rogues in tomato. Darlington and Mather² believe this character is plasmagenically inherited, like other forms of rogues in inbreeding species. An investigation was therefore made to determine whether truss position and plasmagenes also influence pleiocotyly, that is, the variation in cotyledon number, in tomato (*Lycopersicon esculentum*).

Eight plants of Clucas-99 variety were used, and fruits were harvested from individual trusses. Seeds from each were sown. Fig. 1 gives the mean amount of pleiocotyly occurring in offspring from all plants plotted against truss position. This shows that there is a decrease in pleiocotyly from the first to the third truss, with a rise at the fourth. This is converse to that for roguing and truss position found by Lewis¹. An analysis of variance shows that $P = 0.01$ for 'trusses' and $P > 0.20$ for 'plants'. Hence, truss position is important in effecting manifestation of pleiocotyly in the offspring; but plants do not differ significantly from one another in their effects, which is not unexpected in an inbred.

As the data strongly indicate that truss position influences pleiocotyly production, and because rogues in tomatoes are possibly plasmagenically controlled, a test was made to see whether rogues and pleiocotyly are associated. One might expect that rogues would produce more pleiocotyly than normal plants if pleiocotyly were influenced by cytoplasmic factors. Table 1 gives data from Clucas-99. A χ^2 analysis for independence gives $\chi^2 = 1.53$ and $P > 0.20$. Hence roguing and pleiocotyly are independent of each other; however, pleiocotyly produce twice as many rogues. This provides further evidence that cytoplasmic effects are not primarily responsible for the production of pleiocotyly, but might play some part in their activities.

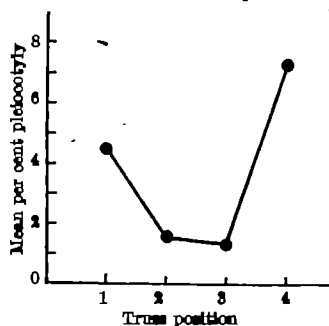


Fig. 1. Per cent pleiocotyly frequency in Clucas-99 tomato variety plotted against position of truss (lowest is 1, highest is 4). Each spot represents the mean of eight plants.

Table 1. DISTRIBUTION OF PLEIOCOTYLY IN NORMAL AND ROGUE CLUCAS-99 TOMATO

Type of pleiocotyly	Normal seedlings	Rogue seedlings
Monocot.	1	0
Dicot.	27	7
Dicot.-abnormal	2	1
Pseudo-tricot.	4	1
Tricot.	9	7
Pseudo-tetracot.	2	1
Tetracot.	1	0
Total	46	17

Table 2. PLEIOCOTYLY IN STONER'S EXHIBITION TOMATO

Cross	Dicot. (per cent)	Pleiocot. (per cent)	No. of rogues
Normal selfed	100	0	0
Rogue $\times$ normal	96	4	0
Normal $\times$ rogue	98	7	1 pleiocot.

Data were also available for Stoner's Exhibition variety. Dr. D. Lewis (unpublished) has found the distribution of pleiocotyly as given in Table 2. Here again pleiocotyly were not rogues; but pleiocotyly increased in proportion following reciprocal crosses between rogues and normal. This suggests that dicotyly is a condition partly resulting from balance between chromosomes and cytoplasm. When one or other is disturbed, the threshold for dicotyly is broken down and pleiocotyly results.

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¹ Lewis, D., *Ann. Rep. John Innes Hort. Inst.*, 1949, 11 (1950).

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Some Polyenes from *Brassica rutabaga*

ROBERT studies on fruit and vegetable processing have shown some natural constituents of the material to be very sensitive to treatments, particularly heat. In the course of dehydration experiments with roots of *Brassica rutabaga*, the pigmentation of the tissues has been examined in detail.

Extraction of the pigment was carried out in the dark by means of a low-temperature technique¹, and subsequent chromatographic analysis of the solution on an alumina column yielded several polyenes adsorbed less strongly than all-*trans*-lycopene. Their absorption spectra after repeated chromatography showed single absorption maxima in the region 420-450 m μ with no fine structure, and all except No. 5 failed to agree with known maxima either for naturally occurring poly-*cis*-compounds^{2,3} or for poly-*cis*-compounds derived from the isomerization of polyycopene⁴. These differences cannot easily be explained by variations in solvent and spectrophotometer. In each case it was possible to obtain all-*trans*-lycopene from the solution of chromatographically pure pigment by isomerization with iodine⁵. These pigments are, therefore, hitherto uncharacterized poly-*cis*-lycopenes. Pigment No. 5 showed a close resemblance to poly-*cis*-lycopene IV isolated from pyracantha berries by Zeiselmeister⁶.

We believe that these pigments should have a more distinctive numbering than that referring to their position on an adsorption column, and make the following proposal, namely, that the figure for

ABSORPTION MAXIMA OF SOME OF THE PIGMENTS ISOLATED FROM *Brassica rutabaga*

Development sequence on alumina column	Absorption maxima in petroleum ether ¹ boiling point, 60–80° C.		Identity of pigment	
12	Not examined		Thus consists of a large number of bands including all- <i>trans</i> -lycopene	
11	410–20*		Poly- <i>cis</i> -lycopene 37	
10	Not examined			
9	Not examined			
8			Poly- <i>cis</i> -lycopene 24	
7			β-Carotene	
6	381	379 400	Poly- <i>cis</i> -lycopene 32 54	
5			Poly- <i>cis</i> -lycopene 26	
4			Poly- <i>cis</i> -lycopene 29	
3			β-Carotene	
2			Poly- <i>cis</i> -lycopene 18	
1 yellow fluorescent	352 347.5 367	397 418 421	Unknown	
1 white fluorescent	Maxima at 397 and 421 may be due to contamination with η-carotene		Unknown	
	329 346 366			

* Regions of inflexion

the main absorption maxima in the region 400–500 mμ in petrol ether of boiling point 60–80° C., deleting the first numeral, be placed after the words poly-*cis*-lycopene. For example, the poly-*cis*-lycopene with its absorption maximum at 429 mμ would become 'poly-*cis*-lycopene 29'.

Of particular interest is pigment No. 2 with a maximum at 418 mμ. This is the shortest wavelength maximum yet recorded for any lycopene isomer, and its position does not concur with present theories for spectral displacements for *cis* bonds by which all-*cis*-lycopene would be expected* to have its maximum in the region of 430 mμ.

Other polyenes identified in this group of pigments were zeta-carotene, beta-carotene, and a group of yellow fluorescent compounds.

This work forms part of the programme of the Ministry of Food, Scientific Adviser's Division.

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¹ Joyce, A. E. (In preparation).² Zechmeister, L., and Pinckard, J. H., *J. Amer. Chem. Soc.*, **69**, 1930 (1947).³ Deod, Jun., H. J., Ganguly, B., Koe, B. K., and Zechmeister, L., *Arch. Biochem. Biophys.*, **33**, No. 1 143 (1951).⁴ Zechmeister, L., and Le Rosen, A. L., *J. Amer. Chem. Soc.*, **64**, 1075 (1942).⁵ Zechmeister, F. P., Harper, B. H., and Nash, H. A., *Arch. Biochem.*, **5**, 211 (1944).⁶ Zechmeister, L., *Chem. Rev.*, **34**, 267 (1944).

some cases, but we wish to record very briefly some of our observations on the living male germ cells of the grasshopper *Chrotogonus* sp. and the common house cricket *Gryllus domesticus* made under the phase-contrast microscope, after studying the spermatogenesis of these two insects by the normal laboratory technique of fixing and staining.

We have seen very clearly in the living cells not only the mitochondria, the Golgi elements, the chromosomes even in resting cells, and the acrosomal vesicle with the acrosomal granule dancing within it, but also the spindle fibres and the mid-body granules.

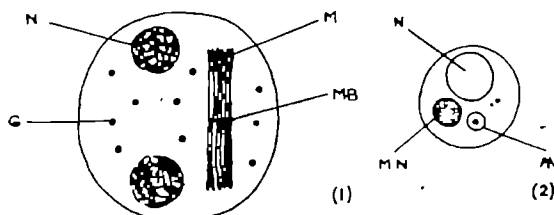
Out of scores of figures recording these observations, we have selected only two. Fig. 1 represents the late telophase II of *Chrotogonus* sp. The nucleus (N) of the secondary spermatocyte has already divided into two; and the spindle fibres with the mid-body granules (M.B.) at their equator and the filamentous mitochondria (M) at their two poles can be very clearly made out. The Golgi elements exist at this stage in the form of vesicles (G) spread out uniformly in the cell. Fig. 2 represents an early spermatid of *Gryllus domesticus*. At AV is shown the acrosomal vesicle with its contained acrosomal granule; at N is the nucleus; and at M.N. lies the mitochondrial nebenkern.

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Are Spindle Fibres and Mid-body Granules Artefacts?

In consonance with the colloidal conception of protoplasm, it is generally believed that the fibres and the mid-body granules of the mitotic spindle are coagulation effects and are not an image of reality. The spindle is conceived as a fusiform area of protoplasm having high viscosity. This may be true in



Selective Absorption of Optical Antipodes by Proteins

We wish to report the resolution of α-methoxyphenylacetic acid on wool, the (+)-form of the acid combining preferentially, when wool is immersed in a dilute aqueous alcoholic solution of the (±)-acid at the room temperature.

In previous communications¹⁻³ we have shown that mandelic acid and many of its derivatives carrying simple nuclear substituents, and several analogous acids derived from larger aromatic nuclei, such as naphthalene, anthracene and diphenylene oxide, are resolved without difficulty on wool. In all these instances, the acids carried hydroxyl groups, and there was the possibility that the difference in the

degree of absorption of the two forms of the anion was due to a difference in the extent of the interaction of their hydroxyl groups with the protein.

Our present result shows that the occurrence of resolution is not restricted to the hydroxy acids. Indeed, the degrees of resolution of α -methoxyphenylacetic acid and mandelic acid are of the same order under the same conditions.

The α -methoxyphenylacetic acid used in our experiments was prepared by Reeve and Christoffel's method⁴; it melted at 70° (literature: m.p., 70.5–71°). Wool (30 gm.) was immersed in a solution of the ($\pm$)-acid in 500 c.c. of a mixture of equal volumes of water and alcohol, and after a time the amounts of the acid absorbed and not absorbed, and the rotations of the two fractions, were determined.

	Exp. 1	Exp. 2
Initial weight of acid in solution	7.31 gm.	7.83 gm.
Period of immersion	18 hr.	24 hr.
Weight of acid absorbed	2.54 gm.	2.45 gm.
Weight of acid unabsorbed	4.76 gm.	5.38 gm.
Rotation of acid absorbed	+ 0.19°	+ 0.20°
Rotation of acid unabsorbed	- 0.19°	- 0.20°

The rotations were measured in a 2 dm. tube in a Hilger model, Type M 413, polarimeter, each of the two fractions being dissolved in 17.5 c.c. of alcohol. They are of the same order as those obtained with mandelic acid⁵ in similar circumstances, and if the molecular rotations of the two acids do not differ greatly it would follow that mandelic acid and its methyl ether are resolved to almost the same degree; $[\alpha]_D$: (–)-mandelic acid, –159.73°, in water⁶; (+)-mandelic acid, +156.40°, in water⁶; (–)- α -methoxyphenylacetic acid, –165.8°, in water⁷; (+)- α -methoxyphenylacetic acid, probably not optically pure, +54°, in alcohol⁸.

It is now possible to recognize some of the factors which enable the resolution of acids on proteins to be demonstrated. The protein itself must carry an adequate number of basic groups. Thus, resolution of mandelic acid has been shown to occur on wool and casein but not on silk^{1,2}. The molecular rotation of the acid should be high, for the degree of separation of the optical antipodes so far observed is small. The acid should not contain groupings which favour the non-specific absorption of its anions by non-ionic forces. Thus, whereas *p*-methoxy, *p*-ethoxy, *p*-pentoxy and *p*-heptoxy mandelic acids are resolved without difficulty on wool, *p*-hexadecoxymandelic acid is not resolved at all⁹. Similarly, many acids containing azo-groups are not resolved on wool^{10,11}.

The resolution of acids on proteins and the extent to which it occurs is of considerable interest for the theory of biochemical processes. It has always appeared feasible that the difference in behaviour of the optical antipodes of the α -amino-acids, the α -hydroxy acids and other acids in natural processes could be related to the preferential absorption of one or other of the two enantiomorphs. Our results do not support this view; for although we have demonstrated the resolution of acids on proteins, the degree of resolution has always been small and insufficient to account for the striking differences in biochemical properties which are often observed, unless the degree of separation can be increased in natural

processes, as by continued resolution at a succession of surfaces.

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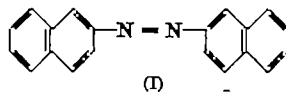
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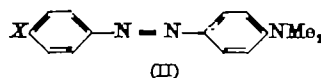
¹⁰ Henderson, G. M., and Rule, H. G., *J. Chem. Soc.*, 1568 (1939).

Carcinogenic Azo-compounds

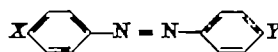
In 1940, Cook *et al.*¹ reported that 2:2'-azo-naphthalene (I) produces cancers of the liver in mice. The compound was also given to rats by subcutaneous injection, and with the food; but in this species no neoplastic changes were found in the livers. There is a brief note in the 24th Annual Report of the British Empire Cancer Campaign, 1947, p. 147, that a few small areas of cholangiectasis were observed in three out of eighteen rats receiving this compound by the oral route. No further details have been published, but Dr. A. H. M. Kirby has kindly informed us (see Kirby, Ph.D. thesis, London, 1949) that he obtained a number of foci of hepatoma in rats surviving more than 500 days. These rats were maintained on a balanced diet and were given the azonaphthalene orally. This behaviour is in marked contrast to 4-dimethylaminoozobenzene (II, X = H), which is a liver carcinogen in rats, but which is very much less active in mice. However, 4-dimethylaminoozobenzene is only effective as a liver carcinogen when tested in rats which are maintained on a diet that is low in protein and in riboflavin², and the original experiments with 2:2'-azonaphthalene were completed before the importance of the diet had been established. It therefore seemed of interest to re-test 2:2'-azonaphthalene for carcinogenic activity in rats maintained on a suitably restricted diet, for direct comparison with 4-dimethylaminoozobenzene. At the same time, an opportunity has been taken to test other azo-compounds which are also of interest in the study of the relationship between chemical constitution and carcinogenic activity³.



(I)



(II)



(III)

All experiments were carried out with batches of ten Wistar hooded rats, which were given food and water *ad lib*. The diet was similar to Kirby's R.D. 3⁴, except that white flour was used instead of rice starch. Control rats lost weight when maintained on this diet; but no abnormalities could be detected in the livers of animals killed after six months. To

Compound	Tumours Survivors	Relative carcinogenic activity (ref. 3)
2:2'-Azonaphthalene (I)	0/9	0
1-Benzeneazobenzene	0/8	0
2-Benzeneazobenzene	0/6	0
4-Dimethylaminoazobenzene (II, X = H)	7/7 8/8	++
4:4'-Di(dimethylamino)azobenzene (II, X = NMe ₂)	0/8	0
4'-Methoxy-4-dimethylaminoazobenzene (II, X = OMe)	4/10	+
4-Methoxyazobenzene (III, Y = OMe, X = H)	0/7	0
4:4'-Dimethoxyazobenzene (III, X = Y = OMe)	0/8	0

establish the effectiveness of this restricted diet, and to enable comparisons of relative carcinogenic potency to be made with other workers⁴, two groups of rats were given the diet to which 4-dimethylaminoazobenzene had been added at a level of 0.08 per cent. The surviving rats were sacrificed after six months, and tumours were observed in all the livers and confirmed by histological examination (see table). Other workers have also obtained a 100 per cent incidence of liver tumours with this compound when tested under somewhat similar conditions⁴.

When tested under the same conditions at the same dose-level (on a molecular weight basis), 1-phenylazonaphthalene and 2-phenylazonaphthalene proved to be inactive. 2:2'-Azonaphthalene was similarly ineffective, no abnormalities being observed in the livers of any of the surviving animals. It can only be concluded, therefore, that 2:2'-azonaphthalene has little or no carcinogenic activity in the rat, when tested under conditions in which 4-dimethylaminoazobenzene is a very effective carcinogen.

It has been suggested¹ that, in the liver of the mouse, 2:2'-azonaphthalene may be converted into 3:4:5:6-dibenzoazobenzene, a polycyclic aromatic compound which is known to produce tumours at the site of application as well as in the liver. The present results are interesting in this connexion; but they are not inconsistent with such a view, for the absence of activity in the rat may be associated with a different metabolic pathway in this species.

Many substituted 4-dimethylaminoazobenzenes (for example, II) have already been tested for carcinogenic activity, and the results appear to be consistent with the view that activity is associated with an optimum density of electrons around the azo-linkage³. In agreement with the conception that there is an upper limit in electron density, 4:4'-di(dimethylamino)azobenzene (II, X = NMe₂) has now been shown to be entirely inactive (see table). Furthermore, 4'-methoxy-4-dimethylaminoazobenzene (II, X = OMe) was found to be moderately active, but less effective than 4-dimethylaminoazobenzene itself. All ten livers of this group showed varying degrees of diffuse fibrosis both to the naked eye and microscopically. Four of the ten showed localized white nodules varying from 4 to 10 mm. in diameter, which appeared to be neoplastic bile-duct epithelium. These areas often contained dilated cystic spaces having an angiomatous appearance. It seemed that tumours developed in the livers already showed bile-duct proliferation, the distinction between the two processes being rather subtle.

The amino-group seems to be essential for activity in this class of compound (that is, apart from azonaphthalene, which may act by a different mechanism), for 4-methoxyazobenzene and 4:4'-dimethoxy-

azobenzene (III, X = Y = OMe) were both found to be inactive.

We are indebted to Mr. H. R. Marston for the animals used in these experiments; we would also like to express our indebtedness to the University of Adelaide Anti-Cancer Committee for financial assistance.

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Aromatic Aldehydes as Specific Chromatographic Colour Reagents for Amino-Acids

THOUGH some aromatic aldehydes have been used as amino-acid reagents^{1,2}; it was thought that a survey of available aromatic aldehydes would lead to the discovery of colour reactions useful in amino-acid chromatography.

The initial reaction between amino-acids and aromatic aldehydes is the formation of Schiff's bases. This, however, is only one of the possible reactions occurring. For example, hydroxyl substituted aromatic aldehydes have quinonoid potentialities and thus have carbonyl activity, in addition to that of the aldehyde group itself, which may result in more complex reactions. When the reagent contains the group $-\text{CO}-(\text{OH}=\text{CH})_n-\text{CO}-$, Strecker type reactions³ may occur. Also aerial oxidation may be a further complication.

In general, the method of investigation used was as follows. The range of common amino-acids were run on one-way chromatograms, 5 μ l. each of $M/100$ solutions being used. The sheets were dried and dipped in a 2 per cent solution of the aldehyde in acetone or *n*-butanol. The sheets were heated and observed in daylight and ultra-violet light. Benzaldehyde, cinnamic aldehyde, *p*-aminobenzaldehyde, and 2,4-dichlorobenzaldehyde give negative results; *o*-, *m*- and *p*-hydroxy-benzaldehyde give weak yellow colours with most amino-acids in daylight and ultra-violet light; ornithine and lysine give a strong yellow in the ultra-violet; 2,3- and 2,4-dihydroxybenzaldehydes give quite strong colours, but variable results occur with slight differences in heating. This is probably related to the complex reaction potentialities of the keto forms.

Vanillin gives red colours with ornithine and imino-acids when followed by 1 per cent alcoholic potash dipping⁴. The chromogenic reaction here is not a simple Schiff's condensation; for when the chromatogram is kept in an evacuated tube after alcoholic potash treatment and drying, the red colours with imino-acids do not develop. Thus aerial oxidation is probably involved. 2-Hydroxy-3-methoxy benzaldehyde gives similar results to vanillin but is rather less sensitive on the whole.

o-Phthalaldehyde has been previously used⁴ as a specific reagent for glycine, histidine and tryptophan.

We dip chromatograms in a freshly prepared 0.2 per cent solution of *o*-phthalaldehyde in acetone. When the chromatograms are run in acetone-water to which 0.4 per cent urea is added, glycine gives a purple spot instead of the usual green spot. The addition of 0.2 per cent urea to the *o*-phthalaldehyde solution produces a purple colour with glycine run in other neutral solvents. Butanol-acetic acid chromatograms are unaffected by urea. Glutamic acid shows as a red-brown spot under ultra-violet light after dipping in *o*-phthalaldehyde in the presence of urea and heating. This, however, is only observed after running in neutral non-aromatic solvents showing up well on acetone/urea chromatograms. We also find *o*-phthalaldehyde gives a specific colour reaction with taurine. The fluorescence given by histidine, tryptophan and tryptamine fades on excessive heating. The colour given by histidine is yellow only when relatively large amounts of the amino-acid are present; at lower levels it is pale blue. Indole gives no colour reaction. Amino-acids not mentioned give indefinite greyish spots in the presence of urea.

The colour reactions given by *o*-phthalaldehyde are strongly affected by the solvent in which it is dissolved. Apart from the sensitivity being greater in solvents of low boiling-point and high dielectric constant, which one would expect on general considerations, sensitivity is much greater in ketonic solvents than in alcoholic ones of similar dielectric constant. We find *o*-phthalaldehyde to be particularly satisfactory in acetone solution. We also confirm that isatin⁵ and ninhydrin⁶ are particularly effective amino-acid reagents in acetone solution. *o*-Phthalaldehyde, isatin and ninhydrin all have the structural unit required for the Strecker degradation, though this probably only represents a part of the sequence of reactions with amino-acids. Grove⁷ studied the reaction between glycine and *o*-phthalaldehyde and obtained a most complex series of products.

We find that 0.2 per cent terephthalaldehyde in acetone is a specific and sensitive reagent for histidine,

MINIMUM QUANTITIES OF AMINO-ACIDS GIVING SPECIFIC COLOURS
WITH *o*- AND TEREPHTHALALDEHYDES.
One-way 65 per cent acetone chromatograms, run 15 cm.

Reagent	Amino-acid	Conditions	Colour*	Sensitivity (μgm.)
0.2 per cent <i>o</i> -phthalaldehyde	Glycine	10 min. 50°	Green	1.0
"	Histidine	"	Yellow	0.5
"	Tryptophan	"	Yellow	1.0
"	Taurine	10 min. 50°		
		1 per cent alcoholic KOH dip. 10 min. 50° then 10 min. 105°	Red Purple	1.0
0.2 per cent <i>o</i> -phthalaldehyde in presence of urea	Glycine	10 min. 50°	Red Purple	1.0
"	Glutamic acid	10 min. 105°	Red-brown	1.0
0.2 per cent terephthalaldehyde	Histidine	"	Yellow-green	0.05
	Tryptophan	"	Brown	0.20
0.2 per cent terephthalaldehyde, 10 per cent acetic acid	Tryptophan	3 min. 105°	Blue	0.05
"	Tryptamine	"	Yellow-green	0.05

* The colours were observed in ultra-violet light of wave-length 3650 Å., with the exception of those given by glycine, which were observed in daylight.

tryptophan and tryptamine on paper-chromatograms. The difference between the histidine and tryptophan colours is much more clear-cut than with *o*-phthalaldehyde. While we were writing this communication, Jepson and Stevens⁸ reported that the fluorescence given with ninhydrin by tryptamine was much enhanced by addition of 10 per cent acetic acid to the ninhydrin solution. We also find that when terephthalaldehyde is dissolved in 10 per cent acetic acid in acetone more intense colours are observed with tryptophan and tryptamine. This indicates that the reaction mechanism is possibly similar to that postulated by Jepson and Stevens. Under these conditions, tryptophan gives an intense blue fluorescent spot which has a yellow centre at higher concentrations. Histidine, however, gives a less sensitive colour reaction. We thus recommend the acid reagent for tryptophan and tryptamine and the neutral reagent for histidine and for differentiation between histidine and tryptophan. *iso*-Phthalaldehyde gives similar results to terephthalaldehyde, but the sensitivities are lower. Comparison of results with *o*-phthalaldehyde and *iso*- and terephthalaldehydes indicates that the proximity of the aldehyde groups in the ortho isomer plays an important part in its reactivity towards amino-acids.

We thank Dr. J. B. Jepson, Mr. I. I. Smith and Mr. J. F. Grove for discussing this work with us, and for samples of various amino-acids and aldehydes

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Separation and Identification of Alkali Metals on Paper Chromatograms

THE alkali metals do not readily lend themselves to detection on paper chromatograms by general or specific spot reagents, except in high concentration, as, for example, using hexanitro-diphenylamine as a spray reagent for the detection of potassium. A method has been developed which utilizes the production of an insoluble coloured precipitate when potassium, caesium, rubidium and the ammonium ion are treated with a solution of sodium cobaltinitrite. The paper chromatogram is run in the usual fashion and dried. It is then either heavily sprayed with or soaked in a solution of cobaltinitrite. The solution of Kramer and Tiedall¹ or a freshly prepared 10 per cent aqueous solution of solid sodium cobaltinitrite in 5 per cent acetic acid may be employed.

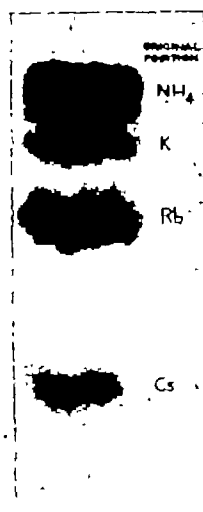
The paper is now washed in cold running water for two or three minutes in order to remove the excess of coloured reagent and reveal the 'spots' of yellow

Solvent system	R_F values			
	K	Rb	Cs	NH_4
Acetone - hydrochloric acid - water (70 : 5 : 25)	0.35	0.33	0.34	0.00
Methyl-n-propyl ketone - acetone - hydrochloric acid (8 : 1 : 1), ref. 8	0.04	0.04	0.04	0.10
Ethanol - hydrochloric acid - water (7 : 1 : 2)	0.17	0.16	0.17	0.46
Butanol - acetic acid - water (50 : 15 : 35), ref. 4	0.33	0.34	0.33	0.23
Benzyl alcohol - acetic acid - water (2 : 1 : 2)	0.26	0.27	0.30	0.23
Diethyl ether - nitric acid, ref. 5	0	0	0	0
Methyl acetate - pyridine - water (2 : 1 : 2), ref. 6	0.03	0.03	0.06	0
Tetrahydrofurfuryl alcohol - water (8 : 2), ref. 7	0.63	0.62	0.62	0.59
Phenol - hydrochloric acid - m-Cresol - acetic acid - water (50 : 2 : 48), ref. 8	0.19	0.27	0.43	0.11
Pyridine - water (1 : 1)	0.05	0.07	0.14	0
Colidine - lutidine - water (1 : 1 : 2), ref. 9	0.54	0.48	0.46	0.41
Mesityl oxide - formic acid - water (1 : 1 : 2), ref. 10	0.12	0.11	0.10	0.04
	0.09	0.11	0.14	0.12

cobaltinitrite of the respective ion. By this technique as little as 5 μ gm. of metal has been identified. The paper is allowed to dry in the air since, when heated, some fading of the spots occurs due to decomposition of the cobaltinitrite. The spot reaction appears to be specific for this group of ions; of thirty-two other metals tested, none gave a yellow spot by this treatment. If the paper is dried by heating and then sprayed with a 0.1 per cent alcoholic solution of α -nitroso- β -naphthol made alkaline with sodium hydroxide, the spots show brown against a pale green background. An increase in sensitivity is gained by this treatment, particularly in the case of ammonium.

This technique of applying a highly coloured reagent followed by washing out excess to reveal a coloured spot has been applied by me to the use of sodium alizarin sulphonate and of quinalizarin for the detection of a wide range of metals. The immediate formation of an insoluble precipitate permits the use of aqueous solutions of the reagents, and the production of compact spots free from any spreading.

Separation of the ions potassium, rubidium, caesium and ammonium was tested in a number of solvent systems. Chromatograms were irrigated by the ascending method¹ on Whatman No. 4 filter paper at 19° C. $\pm$ 1°. R_F values found are shown in the accompanying table.



It will be seen from the table that the only solvent among those tried which will separate all four ions is phenol. This is used equilibrated with 20 per cent (v/v) aqueous hydrochloric acid. The presence of the acid yields sharper spots than are obtained with water-saturated phenol. The accompanying photograph shows a test separation. This was carried out by the descending method using a 35-cm. solvent run. The solution containing about 50 μ gm. of each metal was applied as a narrow streak along the line marked 'original position'. Irrigation was with phenol-hydrochloric acid solvent; the spots were made visible by Kramer and Tis-

dall's reagent and photographed through a blue filter.

In practice, a solution may be applied directly for analysis, or a preliminary concentration and purification carried out by precipitation as cobaltinitrite followed by treatment with hydrochloric acid, evaporation to dryness and solution in water. The cobalt now present in solution runs to R_F 0.09 in phenol and has been shown not to modify the flow or separation of the alkali metals.

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Mixed Crystals of Ice and Ammonium Fluoride

THE "inability of forming solid solutions with any compound" was attributed to water two years ago by Mironov and Bergman¹, who refuted previous reports by Giguere and Maass² and by Kubaschewski and Weber³ of the solubility of hydrogen peroxide in ice. Yet Kathleen Lonsdale⁴ directed attention to the fact that ice and ammonium fluoride are not only isomorphous but also give very similar diffuse star-shaped streaks on Laue X-ray patterns, which were attributed to thermal vibrations of hydrogen nuclei. This great similarity suggested that ice and ammonium fluoride might form mixed crystals.

We have therefore examined the solubility of ammonium fluoride in ice, and we obtained positive results by the following independent methods:

(1) Single crystals of ice frozen from solutions of 0.2 per cent ammonium fluoride gave invariably positive reactions for the ammonium ion when tested with Nessler's reagent, whereas crystals frozen under similar conditions from solutions of 0.1 per cent ammonia gave negative tests.

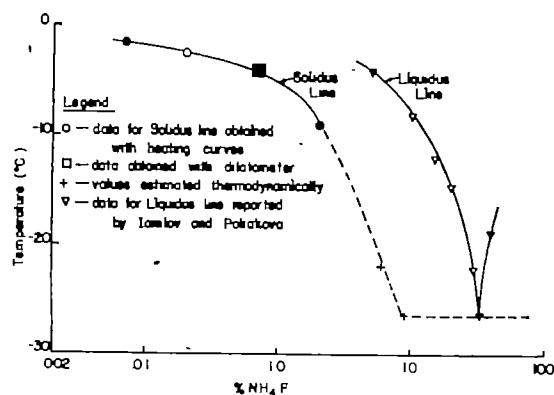
(2) Heating curves for finely powdered ice-ammonium fluoride mixtures showed different thawing temperatures for different concentrations of the latter. These are shown by the circles in Fig. 1.

(3) Dilatometric measurements on ice containing 0.7 per cent ammonium fluoride showed a sudden negative coefficient of thermal expansion at -4° C. which indicated incipient thawing. This is represented by a square in Fig. 1.

(4) Thermodynamic estimates of the solidus curve from data for the liquidus curve previously reported by V. C. Lamlov and E. M. Poliakova⁵ using the modified Clausius-Clapeyron relation:

$$\ln \left(\frac{\text{conc. water in liquid phase}}{\text{conc. water in solid phase}} \right) = \frac{\text{heat of fusion of ice}}{RT} + \text{constant}$$

agree well with the experimental values. The calculated values are represented by crosses in Fig. 1.

Fig. 1. Phase diagram for the system H_2O-NH_4F

(5) We have confirmed the observation of Workman and Reynolds⁶ that the resistivity of ice frozen from solutions of ammonium fluoride increases with the concentration of the latter. On the other hand, substances not forming solid solutions of ice, for example, ammonium chloride, caused an enormous decrease of resistivity with increasing concentration (from approximately 2×10^{11} ohm-cm. for pure ice to about 7×10^8 ohm-cm. for 0.05 *N* ammonium chloride at $-78.5^\circ C$).

(6) Finally, measurements of the dielectric constant of ice-ammonium fluoride at $-78.5^\circ C$. showed a large decrease in the dielectric relaxation time with the concentration of ammonium fluoride within the range of 10^{-4} to 0.1 per cent fluoride, followed by an increase for concentrations greater than 0.1 per cent. Such an effect would not be expected of eutectic mixtures.

These results prove the formation of mixed crystals between ice and ammonium fluoride in a limited range up to about 10 per cent fluoride.

More details about the above-mentioned experiments, as well as results of further work, will be given later. These investigations were carried out under contract No. DA-21-018-eng-500 of the U.S. Army Engineering Corps, Snow, Ice and Permafrost Establishment.

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Conductivity Induced in Insulating Materials by X-Rays

MEASUREMENTS of the conductivity induced in insulating materials by X- and γ -rays have shown the existence of a long period decay¹, and more recent investigations²⁻⁴ have shown that the electron-trapping mechanisms which apply to photoconductivity also apply to these materials. This general picture may enable the energy-level distribution of the material to be elucidated. The present experiments have been concerned with polythene and 'Perspex', and have used a d.o. amplifier to measure the current induced by X-rays of 220 kV_p (half-value

layer = 2.5 mm. copper) both during and after irradiation.

The equilibrium induced current i in polythene is found to be related to the dose-rate R by the relationship:

$$i \propto R^{0.8 \pm 0.05} \quad (1)$$

over the range $R = 0.05-20$ r./min. and between 20° and $80^\circ C$. This is in agreement with the work of Mayburg and Lawrence⁵, who have reported the exponent in the above equation to be $\frac{4}{5}$. This value has been confirmed by Coleman⁶. It is not necessary to assume an ionic conductivity in order to explain either the value of this exponent or the variation of induced current with temperature.

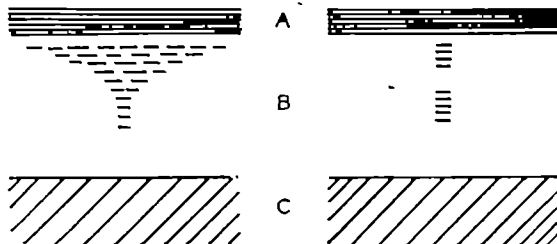


Fig. 1. Distribution of electron traps in energy for polythene (Fig. 1) and 'Perspex' (Fig. 2): (A) conduction levels; (B) normally forbidden levels, with traps shown; (C) full levels

If the models of electron trapping suggested by Randall and Wilkins⁷ and by Rose⁸ can be applied to these materials, we are led to suggest that the distribution of electron traps below the conduction band in the case of polythene is exponential (Fig. 1). Further evidence in favour of this model for polythene is derived from the dependence on temperature and dose-rate of the decay of induced current: the time constant is long, varies slowly with temperature, and decreases with increasing dose-rate. This latter variation is reciprocal for low temperatures and dose-rates, but is proportional to $1/\sqrt{R}$ for higher values of i . The decaying conductivity is inversely proportional to time after about 10 min.; the deeper traps may therefore be distributed more uniformly in depth than the shallow ones.

Rose⁸ gives the variation of equilibrium photo-current with dose-rate and temperature for such a model as:

$$i \propto RNT/(T+T_1) \quad (2)$$

where N is number of energy-levels in the lower part of the conduction band "a few kT " wide, T is temperature of the material, and T_1 is an arbitrary temperature, which, however, may have some physical significance in terms of the molecular structure of the specimen.

For $T_1 = 1,200^\circ K$., the exponent in equation (1) is 0.8. The expression leads to an increase of induced current with temperature by a factor of about ten per $100^\circ C$. near room temperature, and agrees reasonably well with the variation already observed by us³ ($W = 0.42$ eV.), and with the value of $W = 0.3$ eV. obtained by Coleman⁶. Our subsequent measurements lead us to believe that the value is between these figures, probably $W = 0.35$ eV., and we feel that the agreement is becoming more satisfactory.

It is worth noting that the value of W in the relation:

$$\sigma = \sigma_0 \exp(-W/kT)$$

has been determined by Ramsay⁹ for previously irradiated polythene with no incident radiation during the measurement. He found a value $W = 1.45$ eV.,

in close agreement with the value $W = 1.5$ eV. reported by us².

Ramsey found that a new specimen of polythene, prior to any irradiation, gave $W = 0.5$ eV. It is likely that comparatively small doses of X-radiation (10^3 – 10^4 r.) will create new traps in the material at deep energy-levels. We have found a similar increase of activation energy in 'Perspex' from 0.5 eV. before irradiation to 1.2 eV. after less than 10^4 r. The new activation energy does not appear to decrease with time; indeed, measurements on the decay of the conductivity induced in the insulator of small cylindrical condensers by successive weekly doses of 10^4 r. suggest that such changes are not only permanent but also cumulative. Coleman and Bohm observed a similar effect in polystyrene under continuous long-term beta irradiation³.

Measurements similar to those described above for polythene have been carried out on 'Perspex', using a thin disk placed in a vacuum vessel with provision for controlling the temperature. Sheets of polythene have been used in this apparatus for confirming the results obtained with a flat coil of polythene cable, which are given above.

The induced current for 'Perspex' is of the same order as for polythene at 20° C., but the decay is more rapid by a factor of about ten. The dependence of induced current on dose-rate in 'Perspex' is given by:

$$i \propto R$$

over the range 0.5–30 r./min., and between 20° and 90° C. The induced current, moreover, is independent of temperature over these ranges. The time constant decreases with increasing dose-rate. These results suggest that in 'Perspex' the traps are distributed uniformly in depth^{4,5}, with a gap between the deep and the shallow traps (Fig. 2).

More detailed analysis of the growth and decay curves will, it is hoped, yield quantitative information on the distribution of energy-levels in these materials.

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Possible Relation between Deoxyribonucleic Acid and Protein Structures

IN a communication in *Nature* of May 30, p. 964, J. D. Watson and F. H. C. Crick showed that the molecule of deoxyribonucleic acid, which can be considered as a chromosome fibre, consists of two parallel chains formed by only four different kinds of nucleotides. These are either (1) adenine, or (2) thymine, or (3) guanine, or (4) cytosine with sugar and phosphate molecules attached to them. Thus the hereditary properties of any given organism could be characterized by a long number written in a four-digit system. On the other hand, the enzymes (proteins), the composition of which must be completely determined by the deoxyribonucleic acid

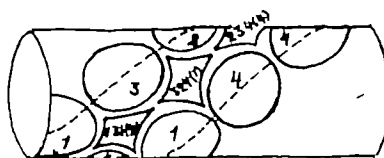


Fig. 1

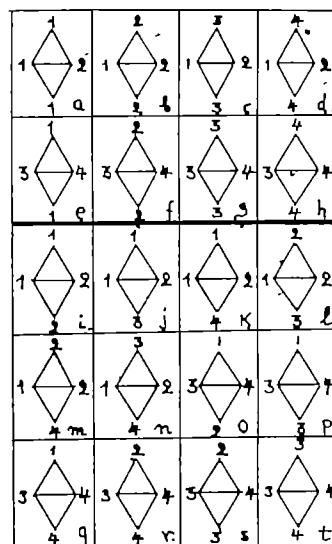


Fig. 2

molecule, are long peptide chains formed by about twenty different kinds of amino-acids, and can be considered as long 'words' based on a 20-letter alphabet. Thus the question arises about the way in which four-digit numbers can be translated into such 'words'.

It seems to me that such translation procedure can be easily established by considering the 'key-and-lock' relation between various amino-acids, and the rhomb-shaped 'holes' formed by various nucleotides in the deoxyribonucleic acid chain. Fig. 1 shows schematically the structure of the deoxyribonucleic acid molecule as derived by Watson and Crick. We see that each 'hole' is defined by only three of the four nucleotides forming it since, indeed, two nucleotides located across the axis of the cylinder are related by $1 \leftrightarrow 2$ and $3 \leftrightarrow 4$ binding conditions. It can easily be seen that there are twenty different types of such 'holes', as shown in Fig. 2. The first eight of them are simple, while each of the remaining twelve can exist either in right-handed or left-handed modification. It is inviting to associate these 'holes' with twenty different amino-acids essential for living organisms.

One can speculate that free amino-acids from the surrounding medium get caught into the 'holes' of deoxyribonucleic acid molecules, and thus unite into the corresponding peptide chains. If this is true, there must exist a partial correlation between the neighbouring amino-acids in protein molecules, since the neighbouring holes have two common nucleotides. There must also exist a correlation between adenine-to-guanine ratios in different organisms, and the relative amount of various amino-acids in the corresponding proteins. The detailed account of the proposed theory will appear in *Kong. Dan. Vid. Selsk.*

G. GAMOW

George Washington University,
Washington, D.C. Oct. 22.

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, February 15

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (at the University, Manchester), at 5.45 p.m.—Prof. A. C. B. Lovell: "Manchester's Great Radio Telescope" (Perovskii Lecture).

INSTITUTE OF METAL FINISHING, LONDON BRANCH (In Room 153, Jannought Building, Northampton Polytechnic, St. John's Street, London, W.C.1), at 6 p.m.—Discussion on "Technical Education—How It Can Help You".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION GROUP (at Savoy Place, London, W.O.2), at 6 p.m.—Discussion on "The Teaching of the Subject of Insulating Materials".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (In the Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6.15 p.m.—Dr. N. J. Berridge: "Inhibitory Substances of Bacterial and Other Origins in Milk and Milk Products".

Tuesday, February 16

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (In Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Mr. J. G. W. Davies: "Vocational Guidance in the Universities".

UNIVERSITY OF LONDON (In the Anatomy Theatre, University College, Gower Street, London, W.O.1), at 1.15 p.m.—Dr. J. L. Watling: "Is It Possible for Us to Know the Future?".

INSTITUTION OF ELECTRICAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, London, W.O.2), at 2.15 p.m.—Mr. G. Henderson: "Mechanisation of Bracken Bracken".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (In the Chemistry Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Dr. K. L. Robinson: "Antibiotics in Animal Feeding".

HUGENIUS SOCIETY (at Mason House, 28 Portland Place, London, W.1), at 6 p.m.—Prof. F. A. M. Crew, F.R.S.: "A Hugenic Appraisal of the Welfare State" (Galton Lecture).

BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Sir Neil Hamilton Fairley, F.R.S.: "Anti-malarial Drugs—Their Action in Different Stages of the Malaria Parasite in Man" (Tenth of fifteen lectures on "The Scientific Basis of Medicine").

INSTITUTION OF ELECTRICAL ENGINEERS (at Central Hall, Westminster, London, S.W.1), at 6 p.m.—Mr. O. W. Humphreys: "Electro-Heat and Prosperity" (Faraday Lecture).

Wednesday, February 17

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.O.2), at 2.30 p.m.—Mr. B. W. Marsh: "Modern Developments in Fungicide Research" (Farnham Lecture).

PHYSICAL SOCIETY, COLOUR GROUP (In the Physics Department, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 3.30 p.m.—Dr. L. O. Thomson: "A Study of the Appearance of Spectral Colours and their Relationship to Miller's Theory of Vision"; Prof. W. D. Wright: "Some Conservative Thoughts on the Trichromatic Theory".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, N.W.7), at 5 p.m.—Scientific Papers.

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. B. G. White: "Microscopy of Antigens and Antibodies Within Tissues by the Use of Fluorescent Antibody".

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (In the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. W. D. Kemp and Mr. B. B. Greenhead: "Electronics in Film Making".

OVERSEAS SCIENCE STUDENTS ASSOCIATION (at the Society for Living Scientists Ltd., 5 Old Burlington Street, London, W.1), at 8.30 p.m.—Prof. H. Dingle: "The Origin and Nature of Science".

Thursday, February 18

ASSOCIATION FOR THE STUDY OF ANIMAL BEHAVIOUR (at Birkbeck College, Malet Street, London, W.C.1), at 10.45 a.m.—Symposium "Behaviour and the Nervous System".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. H. P. Brodie and Mr. A. G. Gaydon: "The Harberg and of O₂ in an Oxygen Afterglow and in the Night Sky Spectrum"; F. J. M. Groosbeck and Mr. F. O. Tompkins: "The Decomposition of Solid Azides by Electron Bombardment".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society, London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. W. B. Shalsh: "Production of Asbestos in South Africa".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—of A. Zygmund: "On the Interpolation of Linear Operators".

PHYSICAL SOCIETY, ACOUSTICS GROUP (joint meeting with the Section of Metals, at 4 Grosvenor Gardens, London, S.W.1), at 5 p.m.—Scientific Papers.

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (In the Lecture Theatre of the Science Museum, South Kensington, London, S.W.7), at 8 p.m.—Report on the recent Congress of the International Union Physics at Houston, U.S.A.

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (joint meeting with the CORROSION GROUP, at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Mr. Hector Campbell: "The Use of Non-Ferrous Metals in Domestic Water Supply".

ROYAL AERONAUTICAL SOCIETY (joint lecture with the HELICOPTER ASSOCIATION, at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. F. J. O'Hara: "Helicopter Research".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. M. G. P. Stoker and Dr. B. P. Marmion: "The Clinical Picture and Epidemiology of Q Fever".

Friday, February 19

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. L. H. Leedham: "The Impact of Development and Research on Production and Design".

UNIVERSITY OF LONDON (In the Physiology Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. W. S. Feldberg: "On Some Physiological Aspects of Histamine".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (In the Chemistry Lecture Theatre, King's College, Strand, London, W.O.2), at 7 p.m.—Scientific Papers.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. Karl T. Compton (U.S.A.): "High Voltage for Cancer Therapy and Food Sterilization".

Saturday, February 20

BIOCHEMICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Symposium on "The Chemical Pathology of Animal Pigments".

BRITISH PSYCHOLOGICAL SOCIETY (In the Psychology Department, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. Hannah Steinberg: "Experiments on Psychological Effects of Drugs".

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. W. Watson: "Ancient Chinese Civilization".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ANALYST (including micro-analyst) (with an honours degree or equivalent qualification) in the CHEMISTRY DEPARTMENT—The Secretary, The University, Aberdeen (February 17).

ASSISTANT EXPERIMENTAL OFFICER or EXPERIMENTAL OFFICER (preferably with a degree in botany or agricultural botany) at the Agricultural Research Council's Unit of Experimental Agronomy, Oxford, for field investigations connected with the development of herbicides and arboricides for vegetation control—The Secretary, Agricultural Research Council, Ounard Building, 15 Regent Street, London, S.W.1 (February 17).

HEAD OF THE DEPARTMENT OF CHEMISTRY—The Registrar, College of Technology, Suffolk Street, Birmingham (February 18).

ANALYST, Experimental Officer grade (with a recognised qualification in chemistry, and preferably with experience of analysis of soils and plants) in the NUTRITION OF FRUIT PLANTS SECTION at the Long Ashton Research Station (University of Bristol)—The Secretary, Research Station, Long Ashton, Bristol (February 20).

ASSISTANT EXPERIMENTAL OFFICER (graduate, preferably with some previous experience in bacteriological work) in the BACTERIOLOGY DEPARTMENT, to take part in research on the intestinal flora of the pig—The Secretary, National Institute for Research in Dairying, Shinfield, near Reading, quoting 54/1 (February 20).

BIOCHEMIST (honours science graduate) for research duties in the Geriatric Department of the Sunderland Hospital Group—The Senior Administrative Medical Officer, Newcastle Regional Hospital Board, "Blythwood South", Osborne Road, Newcastle-upon-Tyne 2 (February 20).

ENGINEERS AND PHYSICISTS (with first- or second-class honours degree in physics or engineering) in the ELECTRONICS DIVISION, for work ranging from fundamental research of electricity and the physics of nuclear radiation detectors to designing and developing electronic devices for the Atomic Energy Project—The Establishment Officer, Atomic Energy Research Establishment, Harwell (February 20).

HEAD OF SCIENCE DEPARTMENT—The Education Officer, Bournemouth Municipal College of Technology and Commerce, Bournemouth (February 20).

ANALYTICAL CHEMIST, Assistant Lecturer grade, in the DEPARTMENT OF AGRICULTURAL CHEMISTRY—The Registrar, Wye College, near Ashford, Kent (February 23).

CHEMIST (with some knowledge of bacteriology, biochemistry, or the chemistry of soils or sewage) with the British Electricity Authority, to study the effects on rivers of power station operations—The Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting T/449 (February 23).

BIOCHEMIST, Scientific Officer grade, in the Older and Fruit Juices Section, at the Long Ashton Research Station, Bristol (University of Bristol)—The Registrar and Secretary, The University, Bristol (February 27).

HEAD OF THE PHARMACY DEPARTMENT—The Principal, Brighton Technical College, Brighton 7 (February 27).

GRADUATE (with first- or second-class honours in geology and training in mineralogy and crystallography) in the DEPARTMENT OF PEDOLOGY, X-RAY SECTION—The Secretary, Macanlay Institute for Soil Research, Craigiebuckler, Aberdeen (February 28).

ASSISTANT (with at least H.S.C. with a science subject or General Certificate of Education to advanced level in a science subject, or equivalent) at the Nature Conservancy's Biological Research Station, Fursbrook, near Wareham, Dorset, to take entire responsibility for care and maintenance of the research laboratories.—The Establishment Officer (L), The Nature Conservancy, 91 Victoria Street, London, S.W.1 (March 1).

LECTURER (with special qualifications in paleontology) in the DEPARTMENT OF GEOLOGY.—The Registrar, Queen Mary College, Mile End Road, London, N.1 (March 1).

SCIENTIFIC OFFICER (preferably with a degree in chemistry, F.R.I.C. or other suitable qualification, and with practical experience in water and/or sewage treatment, and in the physical, chemical and bacteriological examination of water supplies), and a **JUNIOR ASSISTANT** (experienced in chemical analysis of sewage and trade effluents) at the Sewage Treatment Works, Crawley Development Corporation.—The Chief Engineer (Vacancy), Broadfield, Crawley, Sussex (March 1).

SENIOR LECTURER IN EDUCATION at the University of Natal, Durban, South Africa.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Durban, March 1).

RESEARCH ASSISTANT IN PSYCHOLOGY at the University of Durham.—The Secretary, 28 North Bailey, Durham (March 4).

RESEARCH ASSISTANTS (2) (with special qualifications in physical chemistry, and preferably with previous experience in some branch of polymer science) in the DEPARTMENT OF CHEMISTRY.—The Registrar, The University, Manchester 13 (March 12).

ASSISTANT LECTURER IN MEDICAL BIOCHEMISTRY—The Registrar, The University, Leeds 2 (March 15).

DEVELOPER (with high qualifications in one of the sciences bearing on animal health, and considerable research and administrative experience) of MORFUDIN INSTITUTES.—The Secretary, Animal Diseases Research Association, Morfudin Institute, Gilmerton, Edinburgh (March 31).

PROFESSOR OF CHEMISTRY at the University of Otago, Dunedin, New Zealand.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Dunedin, March 31).

PROFESSOR OF PHYSICAL CHEMISTRY, a PROFESSOR OF CHEMICAL ENGINEERING, and a SENIOR LECTURER, in the DEPARTMENT OF CHEMISTRY, University of Natal, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, March 31).

SENIOR LECTURER in the DEPARTMENT OF CIVIL ENGINEERING at the University of the Witwatersrand, Johannesburg, South Africa.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, March 31).

LECTURER in BIOCHEMISTRY—The Secretary, Queen's University, Belfast (April 30).

ASSISTANT, Grade "B" (graduate or A.R.I.C.) in CHEMISTRY, in the Department of Chemistry, Colour Chemistry and Dyeing.—The Principal, Technological College, Queen Street South, Huddersfield.

ASSISTANT METEOROLOGISTS (with H.S.C., or equivalent in mathematics or physics, and preferably with forecasting experience) with the Nigerian Government.—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M8B/33458/TA.

CHEMIST (with an honours degree in chemistry from a British university) in the GEOLOGICAL SURVEY DEPARTMENT, Federation of Malaya, for the analysis of minerals, rocks and metallurgical alloys.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODB106/60/02.

ENGINEERS AND PHYSICISTS, Senior Scientific Officer and Scientific Officer grades (with an appropriate first- or second-class honours degree or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments in London, Portsmouth, Weymouth and Gloucestershire areas, and in Scotland.—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.244/52/A/R.2.

EXPERIMENTAL LECTURER (with high academic qualifications in pure science, preferably in physics or chemistry) in SCIENCE, in the Department of Extra-Mural Studies, King's College, Newcastle-upon-Tyne.—The Director of Extra-Mural Studies, Joseph Cowen House, 145 Barras Bridge, Newcastle-upon-Tyne 1.

MASTER (preferably with first- or second-class honours, Oxford or Cambridge) to teach MATHEMATICS to University Scholarship standard.—The Headmaster, Haberdashers School, Westbere Road, London, N.W.2.

PHYSICISTS (with a good honours degree) to assist in research into the fundamental principles underlying the processing of textile fibres into yarns.—The Secretary, The British Jute Trade Research Association, Kinnoull Road, Kingsway, West Dundee.

PRINCIPAL SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree, or equivalent in physics, and at least three years experience in the construction and operation of mass-spectrometers, and extensive knowledge of their use in both qualitative and quantitative observations) at the Atomic Weapons Research Establishment, Aldermaston, Berkshire, to undertake research and development work in mass spectrometry.—The Administrative Officer, Recruitment, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 01/WGB.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Education. Graduate Teachers of Mathematics and Science: a Report of the National Advisory Council on the Training and Supply of Teachers. Pp. iv+11. (London: H.M. Stationery Office, 1953.) 6s. net. [413]
Monthly Notices of the Royal Astronomical Society. Vol. 113, No. 3 (1953): Annual Report of the Council. Pp. 289-408+plate 3. (London: Royal Astronomical Society, 1953.) 13s. 6d. [412]

Bulletin of the British Museum (Natural History). Zoology. Vol. 1 No. 13: *Suberites Domuscula* (Oliv.) Its Synonymy, Distribution, and Biology. By M. Burton. Notes on Asteroids in the British Museum (Natural History) III and IV. By A. M. Clark. Some Intertidal Mites from South-West England. By G. O. Evans and J. Browning. Pp. 351-423+plates 35-46. (London: British Museum (Natural History), 1953.) 50s. [418]

British Museum (Natural History). The John Murray Expedition 1933-34. Scientific Reports. Vol. 10, No. 1: The Pelagic Tunicate. By Dr. R. B. Seymour Sewell. Pp. 90+1 plate. 20s. Report on Cetaceans Stranded on the British Coasts from 1938-1947. (Report No. 18.) By F. C. Fraser. Pp. 48+9 maps. 12s. 6d. (London: British Museum (Natural History), 1953.) [41]

London School of Hygiene and Tropical Medicine (University of London). Report of the Twenty-Seventh Meeting of the Ross Institute Industrial Advisory Committee. Pp. 24. (London: London School of Hygiene and Tropical Medicine, 1953.) [41]

Colonial Office. Colonial Research 1952-53. Reports of the Colonial Research Council, Colonial Products Research Council, Colonial Social Science Research Council, Colonial Medical Research Committee, Committee for Colonial Agricultural, Animal Health and Forestry Research, Colonial Insecticides Committee, Colonial Economic Research Committee, Tsetse Fly and Trypanosomiasis Research Committee, Colonial Fisheries Advisory Committee, Director—Anti-Louse Research Centre. Pp. 208. (Omd. 8971.) (London: H.M. Stationery Office, 1953.) 7s. 6d. net. [712]

Department of Coal Gas and Fuel Industries with Metallurgy. Report 1951-53. Pp. 23. (Leeds: The University, 1953.) [715]
Bakers of Thioglycollic (Microcaptoacetic) Acid. (T.D.S. No. 4.) Pp. 1+8. (West Bromwich: Robinson Brothers, Ltd., 1953.) [71]

Songs of British Birds recorded by Ludwig Koch. (Published in collaboration with the B.B.C.) Pp. 20. (London: The Gramophone Company, Ltd., 1953.) 2s. [8]

Department of Scientific and Industrial Research. Forest Produce Research. Bulletin No. 29: The Strength Properties of Plywood. Part 1: Comparison of 3-Ply Woods of a Standard Thickness. I. W. T. Curry. Pp. iv+10. (London: H.M. Stationery Office, 1953.) 1s. 3d. net. [8]

Geriatric Periods: a Table and Bibliography. Compiled by J. H. Kenneth, with additions by G. R. Ritchie. Third edition. (Technical Communication No. 5 of the Commonwealth Bureau of Animal Breeding and Genetics, Edinburgh.) Pp. 39. (Farnham Royal, Slough: Commonwealth Agricultural Bureau, 1953.) 7s. 6d. 1.10 dollars. [814]

Other Countries

Publications de l'Institut National pour l'Etude Agronomique du Congo Belge. Série Scientifique No. 57, 1953: Mineral Nutrient Immobilisation under Forest and Grass Fallow in the Yangambi (Belgian Congo) Region, with some Preliminary Results on the Decomposition of Plant Material on the Forest Floor. By Prof. W. V. Bartholomew, J. Meyer and H. Landelout. Pp. 28. (Bruxelles: Institut National pour l'Etude Agronomique du Congo Belge, 1953.) 30 francs. [3011]
Commonwealth of Australia. Department of External Affairs. Australian National Antarctic Research Expeditions. A.N.A.R.E. Reports. Series C, Vol. 1: Terrestrial Magnetism. Magnetic Observations at Heard, Kerguelen and Macquarie Islands, 1947-1951. By F. Jacka. Pp. ii+80. (Melbourne: Antarctic Division, Department of External Affairs, 1953.) [3011]

Mitteilungen des Deutschen Wetterdienstes. Nummer 5 (Oktober, 1953): Taupunkt und Vorhersage der Temperaturminima nach Strahlungslicht. Extremster Fall einer hochgelegenen Mulde. (Donauerschiffen—Barr, 686 m NN.) Von Dr. J. Placitka. Pp. 18. (Bad Kissingen: Deutscher Wetterdienst, 1953.) [3011]
Berichte des Deutschen Wetterdienstes. Nr. 4: Studien zur Meteorologie der südlichen Rhön. Von Dr. Irma Bielebaum. Pp. 16. 2 D marks. Nr. 5: Verdunstungs- und Tauwasserungen in Afrika. Von Dr. Georg Bomm. Pp. 14. n.p. (Bad Kissingen: Deutscher Wetterdienst, 1953.) [3011]

National Research Council. Guide to Scientific and Technical Workers in Egypt. (Classified Subject and Name Indexes and Lists of Institutions in Egypt.) Pp. xx+494. (Cairo: National Research Council of Egypt, 1953.) [3011]

Metropolitan Life Insurance Company. Statistical Bulletin. Vol. 23, No. 10: Outlook for Men Disabled by Coronary Occlusion. Pp. 10. (New York: Metropolitan Life Insurance Company, 1953.) [311]
National Research Council of Egypt. Classified List of Egyptian Scientific Papers. Vol. 2: Papers Published in 1952. (Classified Subject and Author Indexes and Supplement to Vol. 1.) Pp. vii+143. Classified List of Egyptian Scientific Papers. Vol. 1: Papers Published in 1951 (Author Index). Pp. 16. (Cairo: National Research Council of Egypt, 1953.) [311]

World Health Organization. Technical Report Series. No. 74. Expert Committee on Plague. Second Report. Pp. 13. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) 9s. 0.10 dollars; 0.40 Swiss francs; 30 French francs. [311]

World Health Organization. Monograph Series. No. 18. Design and Operation of Berke Tanks. (Third European Seminar for Sanitary Engineers, 27 October-1 November 1952, London.) Pp. 123. (Geneva: World Health Organization; London: H.M. Stationery Office, 1953.) 7s. 6d.; 1.50 dollars; 6 Swiss francs; 490 French francs. [311]

Memoirs of the India Meteorological Department. Vol. 29, Part 5. Equivalent and Equivalent Potential Temperatures. By K. Nagabhusana Rao. Pp. iv+175-230. (Delhi: Manager of Publications, 1953.) 7/4/- rupees; 11s. 6d. [311]

Canada. Department of Mines and Technical Surveys. Mine Branch. Technical Paper No. 5: Effect of Germanium on the Transformation of White to Grey Tin at Comparatively Low Temperature. By R. B. Rogers and J. F. Fyfe. Pp. ii+11. 25 cents. Technical Paper No. 6: The Determination of Uranium in Concentrates by the Fluorophotometric Method. By J. B. Zimmerman, F. T. Rabbitt and H. D. Kornelsen. Pp. ii+9. 25 cents. (Ottawa: Queen Printer, 1953.) [41]

Colloques Internationaux du Centre National de la Recherche Scientifique. No. 35: Particules Fondamentales et Noyaux. Par 24-29 Avril 1953. Pp. 230. (Paris: Editions du Centre de la Recherche Scientifique, 1953.) 1800 francs. [41]

SENIOR PHYSICIST IS REQUIRED TO change of an electrical research section of Laboratories which deals with long-term development work associated with automobile electrical equipment and with the design of electrical instrumentation, etc., to meet the needs of engineering sections. Applicants should have an honours degree with practical development or research experience and a bias towards electronics. The salary will be commensurate with the responsibility which the position carries. There are excellent prospects for advancement. Reply, stating qualifications, experience, age, to Personnel Manager, J. Lucas, Ltd., at King Street, Birmingham, quoting Reference: PM/D/91

UNILEVER, LIMITED, HAVE A VACANCY in their Patent Department for a qualified Chemist, Physicist, or Engineer, preferably with an honours degree. Previous experience in patent work is desirable, but not essential. The position will provide extensive experience in all aspects of British and foreign practice, and the opportunity to qualify as a patent agent. Applications, giving age and full particulars of qualifications and experience, to Personnel Division (B 57), Unilever House, Blackfriars, London, W.C.

GRADUATE CHEMIST, AGE 22 TO 30, REQUIRED for research and development work on synthetic resin emulsions by a company expanding its interests in this field. Salary according to qualifications and experience. Personnel Manager, Dunlop Rubber Co., Ltd., Fort Dunlop, Loughborough, 24.

PHYSICIST REQUIRED TO CONTROL THE physics section of a research and development laboratory. Applicant would be required to work with chemists, metallurgists, and ceramists in developing a variety of semi-conductors, ferroelectric and ferromagnetic materials for the electronic, radio and radar industries. Measurements of the dielectric properties of these materials would be an important part of the work. Applicants should have either an honours degree in physics with a minimum of three years' experience, or a Ph.D. degree will depend on experience and qualifications. Box 837, T. G. Scott & Son, Ltd., 143-147 Fleet Street, London, W.1.

YOUNG LABORATORY ASSISTANT REQUIRED, preferably possessing general certificate of education (advanced level), with one or two years' experience in microbiology. Apply Research Department, Barclay Perkins and Co., Ltd., Brewers, Park Street, London, S.E.1.

FOR SALE AND WANTED

WANTED, THE FOLLOWING HEFTE Pascher's *Schweser-Flora*: 1, 2A, 2B, 3, 5, 6, 7, 8, 13, and supplements to 4, 11, and 12—Headmaster, Gosport High School, Gosport, Hants

GRANTS & SCHOLARSHIPS

BRADFORD EDUCATION COMMITTEE TECHNICAL COLLEGE, BRADFORD DEPARTMENT OF CHEMISTRY AND DYEING WOOL TEXTILE RESEARCH COUNCIL SCHOLARSHIPS

Applications are invited for the following two Research Scholarships, each of the annual value of £300. 1. A Scholarship for research on spectroscopic problems connected with colour constitution. 2. A Scholarship for the investigation into the effect of the modification of fibre on dyeing properties, including electron-microscopy studies. Applicants should have a university degree (or equivalent), with chemistry as a principal subject. Further details may be obtained from the Principal, Technical College, Bradford, 7

UNIVERSITY OF LIVERPOOL

Applications are invited for four Fellowships, value £300 per annum each, and five Postgraduate Studentships, value £200 per annum each, in engineering (including mechanical, civil, and electrical engineering, electronics, and metallurgy). Applicants, which should include particulars as to age, academic qualifications, experience, and the proposed subject of research, together with the names of three referees, should be received not later than April 30, 1954, by the undersigned, from whom further conditions may be obtained. **STANLEY DUMBELL,** Registrar

ROYAL HOLLOWAY COLLEGE

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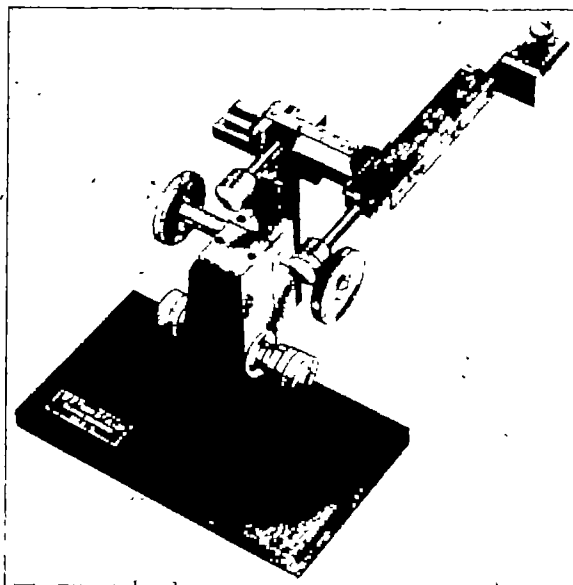
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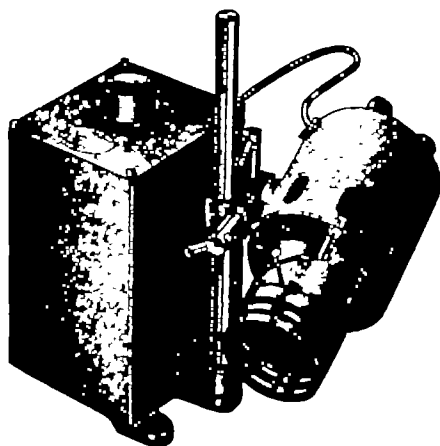
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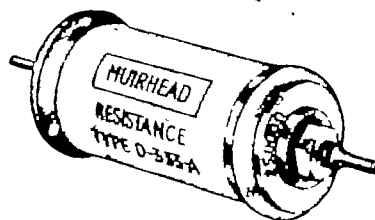
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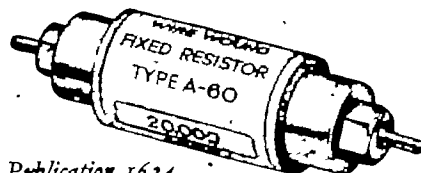
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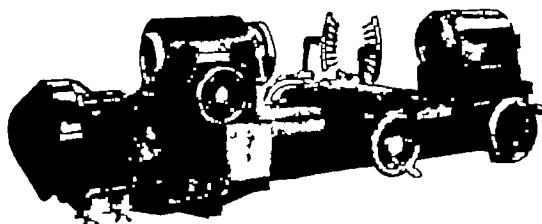


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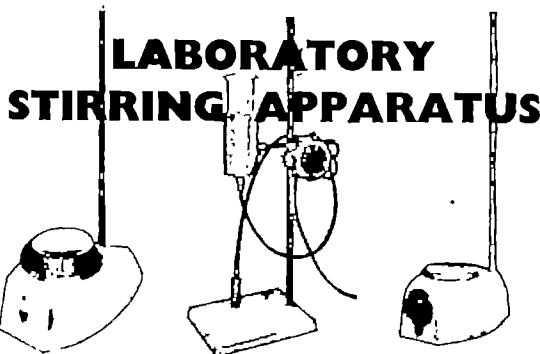
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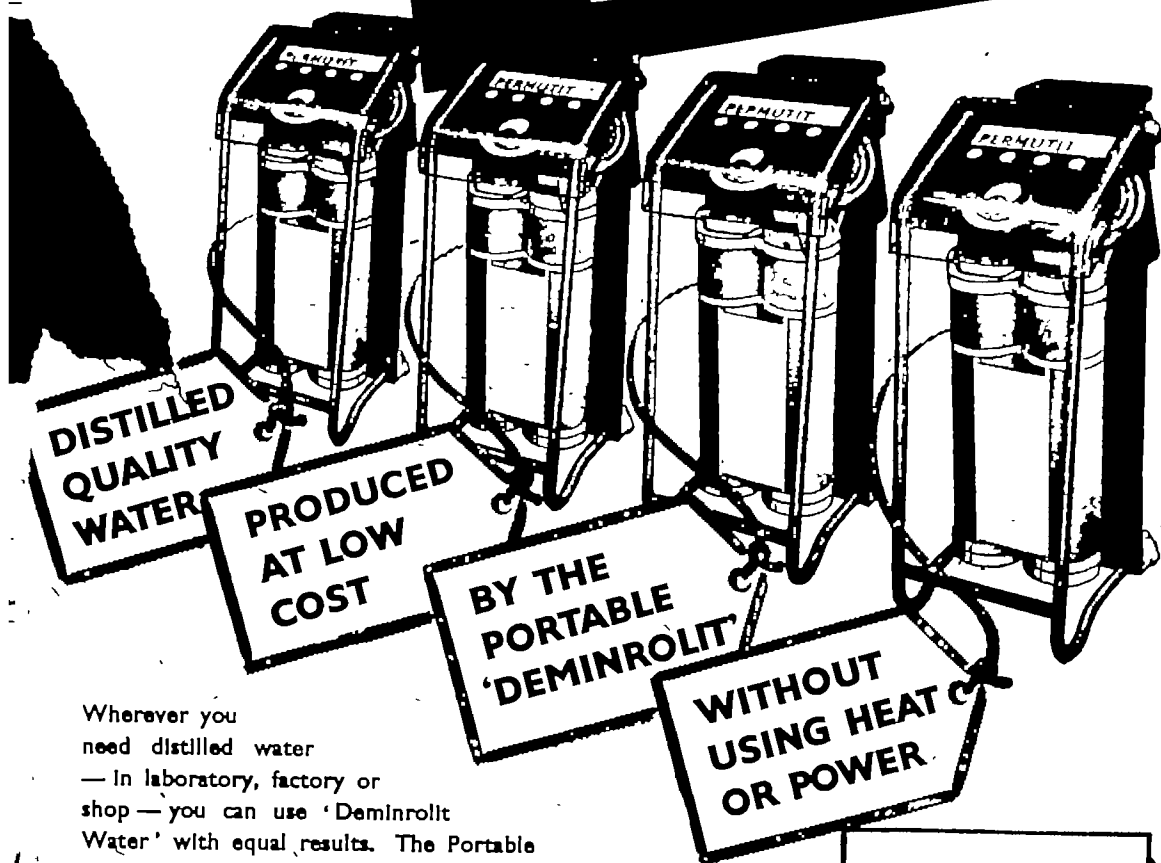
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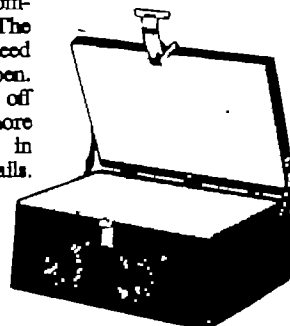
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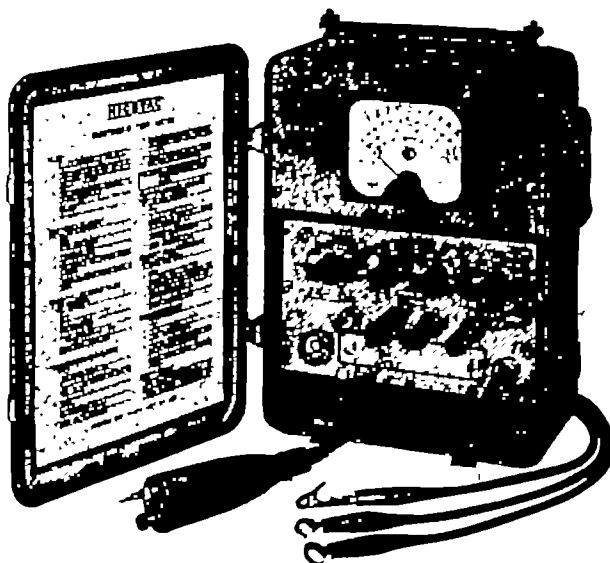
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SCIENTIFIC AND TECHNICAL MAN-POWER IN BRITAIN

IN recent years it has been increasingly recognized that the research associations in Great Britain have an important part to play in technical and technological education. In part this arises out of the greater emphasis which has been placed on their function of securing the greater utilization by industry of existing knowledge. From one point of view this is an educational function; but the research associations can also to some extent help in providing the industries they serve with trained scientific and technological staff. The university-trained scientist may frequently thus acquire the technical knowledge or technological skill which he might find it less easy to acquire in the smaller firm.

There are at present strict limits to what is possible in this way; but the movement of staff from the research associations into industry, and especially if there is some reverse flow, could materially contribute to the fuller staffing of industry with technically trained men able to appreciate the significance of new knowledge and apply it to productive purposes: it could also help to bring the research associations into more intimate touch with industry. The possibilities here may well deserve closer study than they have yet received, and it is therefore appropriate that the rôle of the research associations in technical and technological education should have been the subject of a private conference in London on November 27, attended by the Advisory Council for Scientific and Industrial Research, the chairman and directors of the research associations and some representatives of the universities and technical colleges. Discussion at this conference ranged over a wide field, but was concerned with the relations between the universities and technical colleges and the research associations, rather than between the latter and industry.

Special stress was laid on the value of experience with a research association in providing the graduate with the opportunity for extending his background and gaining appreciation of the technological problems of industry. If, as was asserted by some speakers, university regulations for the admission of students for postgraduate work are too restrictive, relaxation of such regulations so as to permit postgraduate studies under appropriate conditions in research association laboratories might, indeed, prove to be in the national interest, and the conference thought this should be encouraged. It was also recognized that there are possibilities in the exchange of staff and experience between the technical colleges and the research associations which might be further explored, and the conference will doubtless stimulate some further examination of the possibilities of closer collaboration generally by the bodies responsible. Meanwhile, the Department of Scientific and Industrial Research and the Ministry of Education are to arrange for fuller information about the research associations to be available to the technical colleges and vice versa.

The conference is to be welcomed as putting the research associations officially in the general scheme for higher technological education in Great Britain. No policy can now be regarded as complete which does not pay regard to the nature and the magnitude of the contribution which they could make to the training of technologists, of technicians and, indeed, of men for management. From this point of view, because the contribution of the research associations, to be fully efficient, must be interlocked with that of the universities and the technical colleges, the announcement made by Sir Ian Hailbron about the new financial arrangements for the Department of Scientific and Industrial Research is welcome and important. The greater flexibility which the Department will enjoy in planning its educational work, as well as its research, now that unspent monies are no longer to be surrendered at the end of the year, should enable the research associations to plan such developments with the continuity which the quinquennial grants policy has long permitted to the universities.

This is probably the most important feature of the change of Government policy towards the Department which Sir Ian announced. It means that neither a particular research association nor the Department in general need hesitate in future in embarking on some promising research or development which requires more than a year of continuous work before valuable results can be expected, for fear that Government decree would impose financial stringency. It should facilitate both the recruitment of scientific and technical staff of higher calibre and also the interchange of staff with industry and the universities, which was recognized by the conference to be so valuable.

Such consequences, with the interlocking of the work of the research associations and of the Department generally with the whole effort of Britain in scientific and industrial research and in higher technological education; may well be far more important than the actual expansion of the Department's work on which Sir Ian laid considerable stress. With rising costs, the further £6 million expected to be available for new building over the next five years is unlikely to go much further, if so far, as the £1 million a year which it was estimated in 1945 would be required for capital expenditure. Much the same may well apply to the additional £800,000 which the research associations are to receive from the Treasury over the next five years, bringing the Department's contribution from about £1,333,000, out of a total of some £4 million in 1952-53, to about £1,680,000 in 1958-59, when the Department's total expenditure, including about £4,500,000 on its own research establishment, will exceed £6 million a year.

However, although these increases may be less substantial than they seemed at first hearing, and the actual scale of research is unlikely to be increased greatly, the risk of waste of effort and frustration has been greatly diminished, and anxieties expressed in the last two reports from the Advisory Council for Scientific and Industrial Research should be largely removed. Effective planning of research on reason-

ably firm budgeting expectations for several years ahead becomes possible, and the execution of the Department's post-war plans for expansion should bring the scientific needs and resources of Britain into a more satisfactory relation. The basis at least is provided for consolidation as well as for expansion.

It is not only in the field of technical education, however, that the work of the research associations in particular, or of the Department in general, requires consideration in relation to the country's resources and effort in other fields. The new proposals, for example, mean that the Department will recruit yearly a further one hundred and fifty non-industrial and about fifty industrial staff, and will thus be competing further with industry and the universities for the present inadequate supply of science graduates. This is a further reason for early action for dealing with the shortage of science teachers in schools upon which any increase in the supply of science graduates depends. Something much more than the minor suggestions of the report of the National Advisory Council on the Training and Supply of Teachers will be required if the Department is not to find its plans for expansion during the next five years hindered by difficulty in recruiting staff. The Department is as deeply concerned as industry itself with the shortage of science teachers.

It is equally important that an attempt should be made to assess the magnitude and distribution of the nation's research effort in relation to its resources—both in materials or in man-power. One reason for welcoming the Government's proposal to transfer the control of the development of atomic energy from the Ministry of Supply to the Atomic Energy Corporation under the Lord President of the Council is that, provided the Lord President has the requisite staff for his extended functions, a comprehensive review of that effort and those resources should be possible at Cabinet, rather than departmental, level. That much was appreciated by at least some of the speakers on both sides of the House in the debate in the Commons on December 10; but it was equally clear that other members of Parliament have little understanding of what is involved. The arguments against the Order in Council which gives effect to the transfer of functions were ill-judged and, as Viscount Hinchinbrook and Sir David Eccles had little difficulty in showing, largely irrelevant. The really important point was missed. That the present Lord President happens to be in the House of Lords may be fortuitous, as Sir David Eccles said: the magnitude of his scientific and his financial responsibilities are now such, however, that concern can reasonably be felt that there should be no direct spokesman in the House of Commons.

It is not the transfer of functions that is open to question on scientific, technical or administrative grounds, but the tactical omission to provide an appropriate direct spokesman in the House of Commons. The point is one to which the Government should give further attention, and it might well be examined by the Parliamentary and Scientific Committee. So much depends on public confidence,

especially in fields where security reasons hinder anything like full public discussion, that a Government gesture here could do much good. As it stands, that confidence must be earned by the vigour and efficiency with which the Government conducts its policy over the whole field of science and technology. The Lord President of the Council is now in a position to concert an adequate policy. It has yet to be seen whether he has the will and determination to secure the effective implementation of his policy.

Such a policy has two main aspects. One is that of materials and finance. It is this economic aspect that has received most discussion; although, because of the extent to which the expenditure of finance and materials on defence purposes overshadows such expenditure for civil purposes, public discussion here is most hindered by security considerations. A major advantage of the new arrangements for the development of atomic energy is that they bring into the area of public discussion a large segment of the expenditure previously included under the vote of the Ministry of Supply and reaching some £150 million for "Research and Development" in 1952-53. Even if it is still not possible for the headings to be broken down in detail, it should be possible for the nation to gain some rough idea of the relative effort expended on nuclear research in comparison with the total research effort, and accordingly for some independent attempt to assess whether or not that effort is out of balance.

The value of that gain cannot yet be judged fully. Meanwhile, it should be possible for the Lord President to satisfy Parliament that the weaknesses in the organization of research and development effort indicated by the Select Committee on Estimates in its third report for the session 1946-47 and the sources of overlapping and waste of effort there and in relation to defence expenditure to which the Select Committee directed attention in its reports for the session 1948-49, are being carefully watched, and that every reasonable step has been taken to secure co-operation. At a time when difficult decisions in regard to new weapons have to be taken, it is important, just because those decisions and the reasons for them cannot be made public, that Parliament should be given the fullest possible grounds for confidence that there is no administrative slackness or departmentalism hindering co-operation and the effective use of all relevant scientific and technical advance. No such reports have come from the Estimates Committee since the Advisory Council on Scientific Policy became fully operative, and fresh inquiry might be useful.

The second main aspect of policy arises at exactly that point—the use of scientific and technical manpower. This is probably at the present time the most urgent and critical aspect of Britain's whole security: defence and economic security alike turn on her resources of scientific and technical manpower and the use which is made of them. The Government's decision to allow the expansion of the Department of Scientific and Industrial Research to proceed contemplates an increase in the staff of that Department over the coming five years of about

1,000, bringing it to a total of 5,100 in 1959, when the Department should be able to cover some 95 per cent of the activities projected in the 1947-48 plans. It is not yet disclosed what further demands on scientific manpower the plans for atomic energy development will make, but the recommendation of the Advisory Council on Scientific Policy in its last report that more scientists and technologists should be employed in industry has been emphatically endorsed in various quarters.

The implications of the present situation have been brought out in the recent report of the National Advisory Council on the Training and Supply of Teachers. Dealing particularly with graduate teachers of mathematics and science, the report points out that industry is at present taking at least one-third of the annual output of men graduates in mathematics and science at first-degree level, and a good proportion of those who have just completed a period of postgraduate research. Some forty per cent take up research or postgraduate courses or university teaching, and about twenty per cent take up teaching in schools or technical colleges. Of those who obtain honours degrees, some thirty per cent enter industry or commerce, forty-five per cent take up research, postgraduate work or university teaching, and only fifteen per cent go to teach in schools or technical colleges.

The industrial demand for physicists and chemists is still strong, and, although a slackening in the demands for defence might lead to a slight easing of the position there, the unsatisfied demand from industry generally is likely to take up any surplus. Moreover, Prof. M. B. Donald has recently asserted that five times as many chemical engineers are required by British industry as the universities are producing, and Lord Simon told the Court of Governors of the University of Manchester recently that twice the number of engineering graduates now produced could be immediately absorbed by industry. There were two hundred places for engineering students in the universities and colleges of Great Britain which were unfilled last year for lack of suitable applicants. The principal of the Manchester College of Technology, Dr. B. V. Bowden, has also stated that the College could place in good positions at least twice as many graduates as it turns out in a year, and that in some of its departments there is room for thirty to fifty per cent more students.

There is thus no probability of a decreased, but rather of an increased, demand for scientists and technologists for industrial purposes in Great Britain, and especially for work which bears on the improvement of productivity or the export trade. It is in this situation that the inadequacy of the supply of mathematics and science graduate teachers, both in quantity and in quality, to meet the current requirements of schools and technical colleges has to be considered. The average annual requirement over 1955-60 is estimated at more than fifty per cent greater than the present figure, although the National Advisory Council was unable to measure the deficiency exactly from the statistics available. What is unquestionably true is that the standard of

those taking up teaching, as indicated by the degrees they hold, has fallen conspicuously, and that the fall in numbers and quality of science teachers is already affecting the number of students taking courses in science and engineering.

If, therefore, research and development, either in industry, in the public corporations or in Government departments, are not to be impeded by shortage of scientific and technical man-power, the supply of science teachers is a matter demanding urgent and careful action. Something can, of course, be done, both by industry and by the universities, to ease the present situation by looking closely at the use they make of graduates, so as to ensure that graduates are not employed on work that could equally well be done by those less highly qualified. Probably the schools have already done as much as possible to avoid waste of science graduates in classes which do not call primarily for a science graduate, though the report directs attention to the possibilities which a wider use of laboratory assistants in the schools offers.

The recent conference of industrial and educational interests arranged by the Federation of British Industries to consider the problem as it affects industry led to valuable discussion, but the overriding need is still for a policy for scientific and technical man-power, and for this the Government must bear the main responsibility. So far as the shortage of science teachers is concerned, the Ministry of Education cannot escape censure for failure to take energetic action to deal with a situation which has long been apparent qualitatively. To the same Ministry's dilatoriness is largely due the failure to formulate even after months an effective policy for the expansion of the technical colleges. The reply of the Chancellor of the Exchequer, Mr. R. A. Butler, when pressed on this point in the House of Commons on December 8, indicated that while, at the technological level, the Government has in mind the development of at least the Manchester College of Technology as well as the Royal Technical College, Glasgow, expansion at the level of the technical colleges is also contemplated; but he gave no indication that there is to be any balanced and concerted policy.

We require, in fact, not merely an estimate of the national need for scientific and technical man-power which fills the gaps in the survey made for the Advisory Council on Scientific Policy: we need also an estimate of our requirements in regard to technical man-power. Only then will a policy for higher technological education be possible, for it must be in balance with our policy for technical education. The danger of the present piecemeal approach is that the upgrading of technical colleges for the training of technologists may be determined by sectional or local rather than national interests, and may deflect them from the vital task of training the even greater number of technicians that will be required.

An objective view of this whole situation is the first requirement. Without it there is danger that by over-rigid insistence on standards we may expend higher technological education too late and too much,

while failing to expand technical education at the lower level so that industry is provided with the further two or three thousand additional students, not necessarily university graduates, which would make all the difference to technological progress. Short-term measures are required to meet the immediate situation; but they must be in keeping with the long-term measures which are required to provide the permanent steady stream of scientists, technologists and technicians which industry and government and university establishments as well as the schools will require in future.

THE STUDY OF VIRUSES

Advances in Virus Research

Edited by Kenneth M. Smith and Max A. Lauffer.
Vol. 1. Pp. xi+362. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1953.)
8 dollars.

IN the preface to this book, the first of a series which is expected to appear annually, the editors comment on the wide range of periodicals in which articles on viruses now appear. Their commendable aim is to avoid this scatter, at least of review articles; but whether they will succeed only time will tell. Success will probably demand more than what politicians call 'unilateral action', and editors of other series may not automatically forgo their interests in these topical pathogens. More likely, "Advances in Virus Research" will add another to the list of publications virus workers must consult, differing from the others, however, in dealing only with the study of viruses. That the subject now has its own volume is gratifying evidence that it has 'come of age'; but less pleasing is the almost inevitable consequence that workers in it will increasingly be called by the bastard name 'virologist'.

The contents of this volume are said to indicate the scope of the series, in which "the focus of interest is to be the virus". They are: the properties of bacteriophages (H. T. Epstein); interactions between viruses and virus strains (C. W. Bennett); transmission of plant viruses by Cicadellids (L. M. Black); insect viruses (G. H. Bergold); multiplication of influenza virus in the endodermal cells of the allantois of the chick embryo (W. Henle); poliomyelitis (J. L. Melnick); purification and properties of animal viruses (D. G. Sharp); and virus nucleic acids (R. Markham).

The titles show that the series deals with viruses which infect all kinds of organisms; but they do not all accurately reflect the contents or show that the amount of detail given by different authors varies enormously. Epstein's article has a wide title covering one of the most active branches of virus research, but occupies only thirty-five pages, which include twelve sizeable text-figures; it is typical of his summary treatment that lysogenic bacteria get one short paragraph. In striking contrast, Henle's article, with the narrowest of titles, runs to eighty-two pages of unremitting text; the last paragraph starts by saying that "the foregoing sections will have amply demonstrated that the current knowledge concerning the multiplication of influenza virus is still rather limited". Fortunately the contents are more valuable than this quotation suggests, for they

go far beyond the title and cover most kinds of work on influenza virus. Melnick's article, too, has a misleading title; it is not at all concerned with poliomyelitis as a disease, but is an admirable account of current knowledge on the virus. Bennett's is probably the best account yet given of his subject; but the subject is narrower than the title suggests, for he considers only plant viruses.

Two articles deal with insects, one as vectors of plant viruses and the other as sufferers from infection. Black's can be paid the compliment of saying that many who live where leafhopper-transmitted viruses are not yet troublesome would have welcomed more detail. Bergold shows his belief that viruses are organisms by being the only author to give them Latin binomial names, which, incidentally, are already invalid. His apparent lack of interest in the fascinating problems raised by the survival of 'latent' viruses through many generations of insects seems unaccountable.

Markham's essay will be valued by the many pathologists who know little about either the structure or functions of nucleic acids; but it is to be hoped they will not take resistance to nucleases as 'direct evidence' that nucleic acid is held internally in viruses. It may well be, but if we reason the same way from their resistance to proteases, the protein, too, must be held internally. In attempting to cover too much, Sharp has produced a rather scrappy result, which will be useful mainly as a guide to the literature.

At the start of a series, it was perhaps deliberate policy to summarize broad subjects; but this should not continue. This volume amply shows that more satisfactory articles come from the critical examination of limited topics. In future volumes, too, references should be cited uniformly; some authors now refer by numbers whereas others use the better method of names with dates, and some list only journal references whereas others give the titles of papers.

The volume is excellently produced, with detailed author and subject indexes. In the United States the price may seem reasonable; but for the sterling area it is regrettably high.

F. O. BAWDEN

STATISTICAL EXERCISES

Elementary Statistical Exercises, Part I

Issued by the Department of Statistics, University College, London. Pp. 91. (1952.) 6s. 6d. net.

Introduction to Statistical Calculations

By J. Mounsey. Pp. 351. (London: English Universities Press, Ltd., 1952.) 15s. net.

Statistical Tables and Problems

By Prof. Albert E. Waugh. Third Edition. Pp. xiv+242. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 25s. 6d.

GOOD exercises in statistics are hard to find. The essential statistical point is apt to get lost in arithmetical calculations or in pure mathematical analysis. Artificial examples lose that contact with reality which all statistical teachers try to maintain; and examples from the real world become contaminated with practical considerations which are off the essential point. Some statistical text-books do not attempt the setting of exercises at all; and,

among those which do so, there are often many trivial examples and a shortage of good solid ones on which the student may test his knowledge, his grasp of fundamentals and his technical expertise.

The volumes under notice are attempts to fill this gap. The exercises from University College, London, are based on an unrivalled experience of class-work accompanying first-year lectures to undergraduate students taking the B.Sc. (Special) degree in statistics of the University of London. They are all numerical and, broadly speaking, cover univariate theory, regression and correlation, chi-squared and significance tests, sampling distributions and quality control. A second volume is promised to cover variance analysis, experimental design, correlation, probit and discriminant analysis, and curve fitting. The book is very legibly reproduced from typescript and its price is extraordinarily low. One suggestion might very well be made: Could not future editions give the answers, or at least some of the main sums of squares and products, to lighten the burden of a teacher who sets an exercise to ten students and is presented with ten different answers?

Mr. J. Mounsey's useful little book contains about six hundred numerical exercises, but is more than a mere collection. His wealth of examples is knit together by introductory text so that the methods of calculation are explained in detail. The book is designed primarily for students in commercial and technical colleges who are preparing for examinations in statistics, and should prove very useful for that purpose. Its scope is about that of the certificate of the Royal Statistical Society—averages, index numbers, estimates of error, dispersion, lines of best fit, moments, elements of probability, binomial, Poisson and normal distributions and significance tests. There are some tables of the usual kind, and answers to the exercises are provided.

Prof. A. E. Waugh's book, now in its third edition, consists of 35 tables, a list of 137 formulae and a set of about 450 numerical exercises for class work. Many of the tables are of the standard type; but there are one or two unusual (and useful) ones, such as a perpetual Gregorian calendar and a table of the Julian day. No answers are provided, alas, but the exercises contain an abundance of stimulating material.

Teachers and students alike should be grateful for the tedious work which has gone to the making of these collections.

ZOOLOGICAL RECORD FOR 1951

The Zoological Record

Vol. 88. Being the Records of Zoological Literature relating chiefly to the Year 1951. Edited by G. Bunder Stratton. Pp. vi+592. (London: Zoological Society of London, 1953.) 120s.

THE appearance in November 1953 of the eighty-eighth volume of the "Zoological Record" is a notable achievement, for the editor and recorders have at last reduced the delay in publication, caused by the War, to less than two years, thereby much increasing the usefulness of the "Record". Some idea of the task involved may be gathered when it is considered that all zoological publications during the year in question have to be examined and the titles of papers abstracted and afterwards distributed

to the recorders for examination and classification, and then returned to the editor before going to the printers; and finally there is the proof reading involved in dealing with approximately fifteen thousand titles in many different languages.

The present volume follows the same general plan as previous ones for a number of decades and retains a somewhat artificial grouping of the animal kingdom. Thus the section *Vermes* includes such diverse groups as *Platyhelminthes*, *Nemertinea*, *Mesozoa*, *Nemathelminthes*, *Annelida* and a number of smaller classes. It might be an advantage to subdivide this section in accordance with some generally accepted scheme of modern classification, at least for the benefit of subscribers to separate sections.

The value of the "Zoological Record" to all zoologists increases with each succeeding volume, as it furnishes a more-or-less complete bibliography of the subject since its foundation in 1864. Its usefulness has been enhanced in recent years by the adoption of a general plan whereby some indication is given of the contents of each paper which are not always obvious from the title.

The list of titles, arranged alphabetically according to the name of author, is followed by a subject index in which the titles are grouped according to the particular aspects dealt with in the paper, and finally by a systematic index, in which all the species mentioned are listed according to a generally accepted scheme of classification.

The "Record" gives some indication of the work in various branches of systematic zoology in the number of titles in each of the eighteen sections into which it is subdivided. Volume 88 includes the following: comprehensive zoology, 437; Protozoa, 1,126; Porifera, 41; Coelenterata, 274; Echinodermata, 344; *Vermes*, 1,011; Brachiopoda, 211; Bryozoa (Polysoa), 56; Mollusca, 729; Crustacea, 556; Trilobita, 78; Arachnida, 666; Insecta, 1,335; Protochordata, 51; Pisces, 1,088; Amphibia and Reptilia, 1,233; Aves, 2,031; and Mammalia, 1,635. In addition, 1,813 new generic and subgeneric names were recorded in 1951. It will be seen that, as usual, the greatest number of papers deals with insects, birds and mammals occupying the next two places.

Certainly, no taxonomic zoologist can afford to be without this publication, and specialists in all branches of zoology will find it invaluable in dealing with the ever-increasing amount of literature on the subject. The title-page of the "Record" carries the words "Explore solum: sic fit via certior ultra"—a very apt quotation, for the ground is fully explored by the editor and recorders, thus making the way ahead more certain.

EDWARD HINDLE

Prof. J. R. Partington has evidently collected references on physico-chemical subjects over many years. He has read these references, noted their essential points and kept them in remembrance. He has a strong feeling for the great pioneers of the nineteenth century, and his extensive reading of earlier scientific work enables him to do them full justice, and to correct with meticulous accuracy the misconceptions and omissions of text-book writers.

Being based on collections, the book has a museum-like flavour; a museum of old-fashioned type rather than those modern ones with a few well-selected exhibits under brilliant illumination. Each worker's contribution is treated as an object to be found shelf-room. Pride of place is given to those classical subjects which can be developed with rigorous elegance from first principles. More than 130 pages are devoted to Maxwell's electromagnetic theory of light, which is followed from its beginnings to its applications to complex matters of refraction, wave-surfaces in crystals, etc. Other extensive mathematical treatments are of light scattering (50 pages), polarization of light (80 pages), dispersion (16 pages) and diffraction (15 pages). These treatments are clearly presented and, because of the author's desire to bring out the contributions of individuals, are necessarily prolonged. A valuable feature is the attention directed to the varying use of symbols by different authors. The Kerr, Faraday, Cotton and Cotton-Mouton effects are discussed more fully than in any other text-book. The chemist will be grateful for this storehouse of theory, much of which is not readily accessible. The emphasis, however, is always on the mathematical and physical side, and the chemical aspects are somewhat slightly touched on. As an example, fifty pages of highly physical theory on the scattering of light are accompanied by two pages of its applications to solutions of macro-molecules, and three pages to the Raman effect. The same physical bias is present in the treatments of artificially produced double refraction, of the interference of light, and of dichroism, while the several pages devoted to Airy's spirals and radiation pressure seem to be pure physics.

The secondary objects exhibited in the book are the numerous empirical relationships between physical properties which have been put forward by lesser scientists. The author has aimed at completeness in his record, increasing its value for reference, while diminishing it for student reading. In this field he is less insistent on mathematics. About Eyrkman's equation he says: "although it does not yet seem to have been favoured by a theoretical deduction, unlike so many formulae which are useless for practical applications, it is one which deserves to be kept in mind".

The least satisfying part of the book lies in its accounts of instruments and experimental methods. All the ways of measuring interference of light, refractive index, etc., are given with little indication of which a newcomer to research should choose. Only a superhuman scientist, of course, could combine Prof. Partington's range of knowledge in all branches of physical chemistry with an equal skill in all modern experimental techniques. The book will find a unique place in every scientific library and will be constantly consulted both by students and by research workers; all physical chemists who can afford a copy should obtain one.

E. J. BOWEN

PHYSICO-CHEMICAL OPTICS

An Advanced Treatise on Physical Chemistry

By Prof. J. R. Partington. Vol. 4: Physico-Chemical Optics. Pp. xl+668. (London: Longmans, Green and Co., Ltd., 1953.) 80s. net.

THIS fourth volume of the monumental "Advanced Treatise on Physical Chemistry", like the earlier volumes (see *Nature*, 167, 740 (1951); 169, 46 (1952); 171, 853 (1953)), fills the reader with astonishment and admiration for the encyclopaedic knowledge, historical sense, attention to detail and mathematical powers shown by the author.

Stone-worker's Progress

A Study of Stone Implements in the Pitt Rivers Museum. (Pitt Rivers Museum/University of Oxford Occasional Papers on Technology, 6.) By Sir Francis H. S. Knowles, Bart. Pp. 120. (Oxford: Pitt Rivers Museum, 1953.) 15s.

SIR FRANCIS KNOWLES, who died last year, at one time taught physical anthropology at Oxford, and it was he who studied the Mousterian teeth from Jersey and the so-called Red Lady of Paviland. About 1910 he became interested in the techniques employed by man, both prehistoric and modern, when fashioning stone implements, and the present volume is the result of this investigation. Anyone who has tried to describe shortly and clearly the various means by which flint implements can be shaped will know only too well how difficult it is to convey in words the various processes. The so-called Clacton technique is the result of a swinging blow, but, except to a specialist, what does the expression "a swinging blow" convey? Sir Francis, for example, finds himself driven to talk about "the impulsive-pressure-plus-percussion technique". Again, the "punch" technique, so important in late palaeolithic times, cannot entirely be described in a few words. Nevertheless, there is no doubt that "Stone-Worker's Progress" is a valuable book for any student to possess, for it deals with modern stone implements where the processes can be actually observed as well as with the techniques used by prehistoric man which have to be deduced. Anyone interested will knap flint himself, using the book as a guide. In this way he will understand the descriptions and learn the various possible techniques personally. The illustrations, alas, are very poor and not at all worthy of the Pitt Rivers Museum. The illustrating of flint implements is itself a specialized technique, and it is a great pity the figures were not redrawn by someone with experience in the matter. But, none the less, the volume is to be recommended to everyone who wants to know how man learnt to deal with the somewhat intractable material at his disposal. M. C. B.

Scientific Papers Presented to Max Born on his retirement from the Tait Chair of Natural Philosophy in the University of Edinburgh

Contributed by Sir Edward Appleton, David Bohm, Louis de Broglie, Richard Courant, Albert Einstein, Pascual Jordan, Th. V. Kármán and S. S. Penner, Alfred Landé, Erwin Schrödinger, Hermann Weyl. Pp. vi+94. (Edinburgh and London: Oliver and Boyd, Ltd., 1953.) 12s. 6d. net.

THIS collection of essays, presented to Prof. Max Born on his retirement from the Tait chair of natural philosophy in the University of Edinburgh, covers a wide range of subjects, from writers in widely separated parts of the world. One of Prof. Born's important early contributions to the development of the quantum theory was the introduction of the statistical interpretation of the wave function, and it is appropriate that this and related topics are the subjects of essays from several contributors—Einstein, de Broglie, Landé and Bohm—while Jordan writes on the idea of probability in genetics. Schrödinger discusses possible relations between quantum theory and general relativity, and von Kármán and Penner discuss a problem in theoretical chemical kinetics. Appleton provides the only essay in a branch of experimental physics, on geomagnetism and the ionosphere. Two essays, one by Courant on

systems of partial differential equations and one by Weyl on an analytical topic, are primarily of a pure mathematical character. Most of the essays presume some previous knowledge of their subjects, and there may not be many readers to whom these subjects will all be equally familiar; but many will find something interesting and stimulating in one or more of them. An admirable photograph of Prof. Born forms the frontispiece to the volume. D. R. H.

Statistical Design and Analysis of Experiments for Development Research

By Donald Statler Villars. Pp. xvii+455. (Dubuque, Iowa: Wm. C. Brown Company, 1951.) 6.50 dollars.

THIS book is intended to summarize, "for the busy research worker or executive", the principles of experimental design. It cannot be said to succeed. The author has tried to cover too many topics in a limited space, and understanding is further hampered by the prose style, which becomes, at times, discouragingly obscure. Nevertheless, the book has its merits: it avoids the worst excesses of the 'cook-book', despite the adoption of "a journalistic order or presentation . . . so that one may immediately start applying variance analysis to his own data", and the frequent references should greatly assist the conscientious reader.

After an elementary introduction, four chapters are devoted to experimental design and the analyses of variance and covariance; these, with supplementary chapters on "the efficiency of experimentation", "miscellaneous refinements", and the mathematics of variance analysis, comprise the bulk of the work. The discussion of the analysis of variance is generally good. Interpretation by variance components is stressed, but not followed blindly, and the circumstances in which it is appropriate are carefully described. The chapters on design are much less satisfactory. Designs of the 'split-plot' type (here called "replication degeneracy designs") are extensively discussed, and frequent warnings are given against incorrect analysis of such experiments. The section on confounding, however, contains so many mis-statements that one is led to doubt the author's own grasp of the topic, and the brief discussion of the important topic of fractional replication misses the point entirely.

Two further chapters contain short accounts of quality control and sequential methods. Extensive tables are provided. M. R. SAMPFORD

Gestation Periods

A Table and Bibliography. Third Edition. (Technical Communication No. 5 of the Commonwealth Bureau of Animal Breeding and Genetics, Edinburgh.) Compiled by J. H. Kenneth, with Additions by G. R. Ritchie. Pp. 89. (Farnham Royal, Slough: Commonwealth Agricultural Bureaux, 1953.) 7s. 6d. or 1.10 dollars.

THE appearance of a third edition of "Gestation Periods: a Table and Bibliography" in the tenth year after the publication of the first shows how much it has been in demand by naturalists, biologists and others interested in mammalian reproduction. A large number of new entries is included in this edition, many of them referring to species that had not been recorded before. Further information will no doubt be added to this most useful work with the passage of time: it includes everything recorded about the subject up to the time of going to press.

NATURAL HISTORY OF LEARNED AND SCIENTIFIC SOCIETIES

By PROF. JOHN COHEN, C. E. M. HANSEL and EDITH F. MAY

University of Manchester

OUR aim in this study is not that of the historian but is prompted rather by the question whether it is possible to detect principles, preferably quantitative, underlying the formation and growth of human associations. There are several other reasons which make the study of the growth of scientific and learned societies worth while. In the first place, it gives us a comparative measure of the development and dissemination of ideas in different branches of learning at different times. Secondly, it enables us to trace the growth of learned societies in relation to demographic, educational and technological changes. Thirdly, it provides a basis for comparing fields of interest which appear to be adequately represented by single societies with others which give rise to a diversity of groups. In the course of such inquiries matters of historical interest are bound to emerge.

Sources of Data

Our study is limited to British national societies that have survived until 1952, not with those which existed only for a time, though it would seem that the number of such is comparatively small. A list of about 220 national learned and scientific societies was compiled from three sources, "Whitaker's Almanac" for 1951, "Scientific and Learned Societies of Great Britain" (Allen and Unwin, 1951) and "The World of Learning" (Europa Publications, 1951). Nearly all the societies were included in at least two of these three sources.

Societies are described for the present purpose as learned and scientific if their aim as stated in their handbooks is to promote the study and development of a recognized branch of learning. The following types of society were excluded: those which exist solely to promote professional interests, to regulate status or to co-ordinate groups of societies for mutual support. When any of these activities is undertaken by the societies in our series, it is subsidiary to their main object of advancing some branch of learning.

A personal letter was sent to each of the societies with a request for figures of annual membership from the year of foundation onwards, the number of new members year by year, details of conditions of eligibility for membership, and references relating to the history of the society. All the leading societies and most of the smaller ones most courteously and helpfully provided adequate data. Gaps in the material were filled by consulting published records.

Birth of Societies

In the accounts given by the societies of their own origins several patterns are discernible. These patterns to some extent reflect the modes of corporate life characteristic of the period in which the society was formed. For example, in the early nineteenth century gentlemen of standing met in clubs devoted to some political, social or intellectual purpose. They enjoyed open discussion in a limited social group whose members had no need to justify their claims to membership. A society formed on this pattern at the present day would be described as a coterie.

The date when a learned society is founded is an arbitrary, if convenient, point in its history. Like the birth of a child, it marks a new phase but it is not a beginning. The society, like the infant, is first conceived and then passes through a latent phase of gestation before formal establishment.

The most common mode of generation is by the efforts of a single zealous individual. At least a third of the societies we have studied seem to have been inspired in this way. An example is the London Natural History Society, founded in 1858. That was a flourishing time for entomological societies composed of zealous collectors of specimens. As a result of a letter sent by Henry Aris to the *Weekly Intelligencer* in December 1858, the Haggerstone Entomological Society was born. The members met "at the Brownlow Arms in a spacious room over the bar, each member being provided with a long clay pipe, while the necessary refreshments were provided from below, under which soothing influences the science of Entomology was keenly pursued". In 1887 they moved to superior quarters at London Wall, abandoned pipes and pots and rechristened themselves the City of London Entomological and Natural History Society.

Another example is the Quekett Microscopical Club founded in 1865 after a proposal by Mr. W. Gibbon in a letter to *Science Gossip*. The idea found favour in the eyes of the editor, who gave it his support. Early Quekett members seem to have felt that the Royal Microscopical Society was too lofty for the amateur and looked upon the Quekett Club as a kind of preparatory school for the Royal Microscopical Society. One popular feature of the Club's activities was "Gossip Night". In 1944 the Club moved into Burlington House.

Other instances are the British Bryological Society, which owed its origin in 1896 to an advertisement by the Rev. C. H. Waddell, of Saintfield, Co. Down, proposing to set up a Moss Exchange Club; the Royal Meteorological Society, which arose out of a suggestion by J. G. Tatem in the *Monthly Magazine* in 1823 and established itself after some vicissitudes in 1850; the Royal Medico-Psychological Society, founded in 1841 by Dr. Samuel Hitch, of Gloucester, who sent a letter to all doctors in "Public Lunatic Asylums"; and the Anatomical Society, founded in 1887 on the initiative of C. B. Lockwood, a surgeon at St. Bartholomew's Hospital, London. The Anatomical Society prides itself on having accepted women members twenty-two years before the Physiological Society followed suit.

Perhaps the most illustrious member of this group is the Chemical Society, born in 1841. At that time chemistry was being taught in the medical schools, the only professional chemists being doctors or those articulated as private pupils to medical demonstrators in the schools. The man largely responsible for founding the Society was Robert Warrington, a chemist who had been articulated as a private pupil to a lecturer in a medical school. His son records that his father's task was facilitated by the introduction of the Penny Post in the previous year. The

question of admitting women members was the occasion of a long and painful struggle. Eventually a postal ballot held in 1908 yielded a result favourable to women. But the Council interpreted this to mean admission as subscribers only, and only eleven women availed themselves of the privilege.

A variant on this mode of origin is exemplified in the birth of the British Astronomical Association in 1890, from the spontaneous but independent efforts of two enthusiasts, Miss Elizabeth Brown, director of the Solar Section of the Liverpool Astronomical Society, and Mr. W. H. S. Monak, a barrister (who wrote on the subject to the *English Mechanic*). At that time there were many amateur astronomers. The Association was not intended to rival the Royal Astronomical Society but to serve those "who found the subscription to that Society too high, or the papers too technical, or who, being women, were excluded". A notable early member of the Association was a New Zealander, an "astronomical chimney-sweep", Frank Hitchens, who died in 1921, aged seventy-seven. Hitchens was a bricklayer as well as a chimney-sweep and owned a 5-in. refractor which was the largest privately owned telescope in New Zealand. He "pursued a life-long study of astronomy, and he lectured for many years; he was a fellow of the Royal Geographical Society, Canterbury Philosophical Institute, and Canterbury Microscopical Society. He was a valued contributor of records of sunspots to the B.A.A., yet his sole schooling consisted of a few weeks at a night school".

About one-sixth of the scientific societies owe their origin to a budding-off from some existing body. The Royal Astronomical Society, born in 1820, seems to have been a rebellious child of the Royal Society, and the Geological Society appears to be an offspring of the same parent. In his historical account of the Royal Society of Tropical Medicine and Hygiene, Dr. S. H. Dawkes suggested that "there would seem to be some need for contraceptive methods with regard to learned and quasi-learned societies". We must be thankful that the Royal Society did not find it necessary to employ such methods.

The Biochemical Society, born in 1911, was the offspring of a kindlier parent, the Physiological Society, five years after the launching of the *Biochemical Journal*. T. A. Gardner and R. H. A. Plimmer were leading spirits. The Society began as a club with meetings always followed by dinner, unlike the parent body, which in its youth was accustomed to meetings preceded by dinners. Doubtless this change in the sequence of activities had its beneficial effects. Meetings were irregular at first. Women were not admitted as members, and there was no president. The club became a society in 1911, the year in which it purchased the *Biochemical Journal*. In 1944 the Society initiated the Biological Council, which includes the Physiological, Anatomical, Pathological and Linnean Societies and the Society for Experimental Biology.

The Royal Statistical Society enjoyed a similar kind of birth in 1834. At the third meeting of the British Association, Quetelet wished to present some statistical material but discovered that there was no suitable section. The upshot was that a number of "noblemen and gentlemen" met later in London to establish an independent society.

The remaining half of the societies seem to have come into being: (1) to launch or support a journal; (2) to preserve a library, private laboratory, a collection of specimens left as a legacy, or dispose of

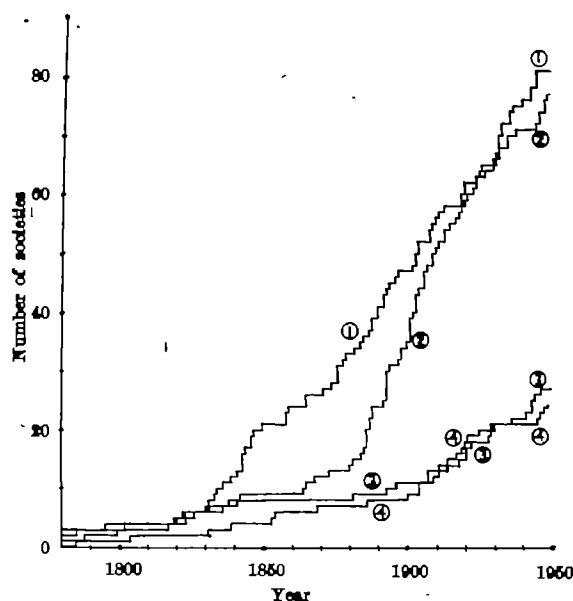


Fig. 1. Cumulative number of learned and scientific societies by date of foundation: (1) scientific societies, including general science, natural science, archaeology, sociology and anthropology; (2) the humanities; (3) medical societies; and (4) technological and agricultural societies.

some fund; (3) to enable the dying spirit of a moribund group to transmigrate into a new body; (4) as a collective effort of a group of workers already in informal contact; (5) as an expression of professional defence against hostile interests.

An example of group (1) is the Society for Experimental Biology, which was initiated by the Editorial Board of the *British Journal of Experimental Biology* in 1923 partly to find financial support for the journal.

The formation of the Scottish Marine Biological Association in 1897 illustrates group (2). Its origins may be traced to a committee set up in 1894 to take over Sir John Murray's floating laboratory at Millport. The Association has changed its name three times. Another example is the Friends of the Polar Institute, formed in 1920 with the surplus remaining from the Lord Mayor's Memorial Fund for Scott.

A representative of group (3) is the Botanical Society of the British Isles formed in 1836 and descended from the Botanical Society of London, founded by Daniel Cooper.

The Royal Society of Medicine formed in 1805 is another member of this group, although its wide scope gives it a character of its own. It was originally founded as the Medical and Chirurgical Society of London, the members of which had resented "the tenacious occupation of the Presidential Chair" of the Medical Society of London by Dr. James Sims. He had occupied it for twenty-two years. The leading figures were Dr. Marcet and Dr. Yelloly, and a Royal Charter was granted in 1834. Several attempts were made to bring the chief medical societies into a single union; but there were always societies which resisted. In 1907 eighteen societies joined and the Society assumed its present title. A distinguished society which did not enter into the 1907 amalgamation is the Royal Society of Tropical Medicine and Hygiene, and another which resisted in 1912 is the Ophthalmological Society of the United Kingdom.

Table 1. FOUNDATION OF NEW SOCIETIES IN TWENTY-YEAR PERIODS

	Before 1700*	1800-19	1820-29	1840-59	1860-79	1880-99	1900-19	1920-29	1940-53
General science	2		1						2
Astronomy			1						
Biology	1		2	3	3	9	8	7	2
Chemistry				1					
Physics				1	1		1	1	1
Mathematics			1		2				
Geology and geography		1	1	2	1	1	1	2	1
Anthropology and sociology				1	1	2	2	3	
Archaeological studies				4	1	1	2		
Technology and agriculture	1	1	2	2	1	1	9	4	4
Medicine†	3	2	1	1		3	4	8	5
Humanities (law, literature, history, philosophy)	3	1	4	1	4	21	24	13	6
Total	10	5	13	16	14	39	51	39	21

* Including the following five societies formed before 1780: the Royal Society (1660), Medical Society of London (1773), the Royal Medical Society of Edinburgh (1778), the Honourable Society of Gynmrodorion (1751), Society of Antiquaries of London (1707).

† Dates of foundation of three societies in this group are not available.

The formation of the British Rheologists' Club (Society since 1951) exemplifies group (4). During the Second World War the secretary of the Institute of Physics, while visiting Dr. Scott Blair's laboratory at Reading, discovered many mutual interests, which led to the founding of a Club. Other examples are the Society for Applied Bacteriology, founded in 1934, and the Marine Biological Association of the United Kingdom. The latter was formed in 1884 by a group of influential people who met to establish a laboratory modelled on Dr. Dohrn's Station at Naples. Among those present at this meeting were T. H. Huxley, Sir John Lubbock and Sir Ray Lankester.

The Physiological Society, founded in 1876, is an example of group (5) and came into being in response to attacks on the work of physiologists. 1876 was the year in which Parliament passed the Cruelty to Animals Act to control the use of animals for experiments. The Act was provoked by opponents of these experiments, and it stimulated physiologists to band together to protect their interests. Another example of this type is the Research Defence Society, founded in 1908 to combat the four anti-vivisection societies existing about that time.

Special interest is attached to a society which illustrates the effectiveness of inbreeding by different generations from the same stock. In March 1897 the X-Ray Society was founded. Three months later it changed its title to the Röntgen Society. In 1902 the Röntgen Society gave birth to a child called the Electro-Therapeutic Society, limited to medical members. In 1905 this child abandoned its parent and joined the family of the Royal Society of Medicine. In 1917 the Electro-Therapeutic Society combined with the medical part of its true parent, the Röntgen Society, to form the British Association for the Advancement of Radiology and Physiotherapy. The Association changed its title in 1924 to the British Institute of Radiology, which finally, in 1927, amalgamated with the Röntgen Society.

There have been many other influences in the past, such as important events or publications, ease of transport and communication and facilities for printing, which have doubtless affected the origin and development of societies directly or indirectly. Among such varied influences may be included, for example, the Scientific Societies Act of 1843, the Great Exhibition of 1851 and Darwin's "The Origin of Species", 1859. Some early societies were necessarily limited to members living within a radius of thirty miles from the society's headquarters.

During the eighteenth and early nineteenth centuries novel problems thrown up by local industries stimulated much scientific activity in provincial centres. Many "little clubs or coterie of scientific and literary men" flourished. There were groups, for example, at Liverpool, Warrington, Bristol, Norwich, Manchester and Birmingham, which exerted a considerable influence on the development of scientific ideas. The Lunar Society of Birmingham, the members of which were popularly known as the "Lunatics", counted among its members Boulton, Watt, Erasmus Darwin, Wedgwood and Priestley, and "the meetings were appointed to be held monthly at the full of the moon, to enable distant members to drive home by moonlight".

Some of the Scottish societies of this period were distinguished by the conviviality of their proceedings. The Harveian Society of Edinburgh, founded in 1782, was preceded by a Faculty Club comprising a group of imaginary physicians who wore wigs and gowns at their meetings. The Society (which was for a time known as the 'Circulation') met annually on the anniversary of Harvey's birthday "to commemorate the discovery of the circulation of the blood by the circulation of the glass". Membership was limited to those proposed at the Aesculapian Club or the Dissipation Club. Dr. Andrew Duncan, the first president, in the conviction that medical men did not take sufficient exercise, established the Gymnastic Society in 1786, where Harveians were to compete with one another at swimming or other sports; but "enthusiasm for this detracted from attendance at

Table 2. NUMBER OF SOCIETIES AND MEMBERSHIP

	Number of societies	Membership*
General science	5	7,900
Natural sciences		
Astronomy	3	5,100
Biological sciences	35	27,300
Chemistry	1	9,100
Physics	5	7,300
Mathematics	3	5,500
Geology and geography	10	15,100
Anthropology and sociology	9	13,800
Archaeological studies	8	6,700
Technology and agriculture	25	117,000
Medicine	30	24,100
Humanities		
Law	7	6,000
Literature and language	31	39,000
Historical studies	33	25,600
Philosophy	6	4,400
Total	211	313,200

* The figures are given to the nearest hundred

Table 3. SOCIETIES IN RELATION TO POPULATION

Year	Estimated population of Great Britain (millions)	Estimated total membership of scientific societies	Total number of scientific societies	Mean membership	Membership per million of population
1850	20.8	6,700	17	394	322
1900	37.0	23,100	43	536	759
1952-53	50.0	89,200	74	1,205	1,784

the Harveian Festival". Among Harveian office-bearers were a Poet Laureate and a Pontifex Maximus. Members were awarded a "Doctorate of Mirth or Merriment" in recognition of "the zest with which they joined in the festivities".

Present Position

Units of measurement. Inspection of the data suggested the use of four units of measurement, namely: (1) the number of societies founded in any period; (2) the number of societies existing at any given time; (3) the age of societies; and (4) size of membership in single societies or groups of societies.

Foundation of societies. Our data relate to national learned societies, of which 134 are scientific, technological or medical, and 77 which are concerned with the humanities. The number of societies founded in each twenty-year period since 1660 is shown in Table 1. It will be noted that the latest period relates to thirteen years only.

A word is needed to explain some of the categories in Table 2. General science includes the Royal Society, the Royal Institution, the British Association, the Scientific Film Association and the Bureau of Scientific Research. The group of biological sciences includes anatomy, physiology and psychology. Historical studies includes history of science, engineering and religion.

Number of members. The membership of each group of subjects as shown in Table 2 was obtained by adding the latest available figures of members of the individual societies; and they relate mostly to 1952-53. An individual may, of course, belong to more than one society. The group figures therefore do not indicate the number of persons. The size of seventeen societies was estimated by taking the mean of their respective groups.

Societies vary in conditions of their eligibility for membership. Some of the more specialized societies, particularly in medicine, restrict members to those having specific qualifications. For example, the British Orthopaedic Association, formed in 1918, originally required candidates for membership to submit a thesis. A few societies limit the size of the society regardless of qualifications. In other cases the limit seems to be raised as it is approached. The experience of the British Pediatric Association shows that abolition of a limit is not necessarily followed by an increase of membership.

Trends In the Growth of Scientific Societies

The main body of the present national scientific societies began to come into existence after the Napoleonic wars. In 1819 only four of the scientific societies in our series were in being. The number in existence has increased steadily since 1850. But the rate of formation of new societies does not seem to have kept pace with increase in membership of the combined societies. During the past century, membership has increased about thirteen times as com-

pared with a four- or five-fold increase in the mean membership of societies. The period since 1880 has shown a great increase in biological and medical societies. Of the sixty-eight established since that date, twenty-six are biological and twenty medical. No mathematical or chemical society has been formed during the period.

Over the past 150 years there has been a steady increase in the combined figures of membership. The increase is greater than might be expected on the basis of increase in the population of Great Britain. Figures at 50-year intervals are shown in Table 3.

The figures in the table include archaeological and anthropological societies but exclude general scientific, medical, technological and agricultural societies, which together numbered fourteen in 1850, twenty-one in 1900 and fifty-seven in 1950. The estimated totals for 1850 and 1900 are based on samples of eleven and thirty societies, respectively, out of the seventeen and forty-two in existence at those dates. The samples consisted of societies for which figures of membership at 1850 and 1900 were available.

When, however, we turn to individual scientific societies we by no means find an increase in all of them after allowance has been made for population increase. The Chemical and Physiological Societies, apart from a drop in the late thirties, have continued to increase in membership. Others, for example, the Geological and Royal Statistical Societies, display certain similarities which include, when allowance is made for population growth, an increase until 1880 and a steady and rather steep decline thereafter until about 1940.

The majority of scientific societies show a sharp rise in membership in the period 1940-50. The societies which show an increase over most of the period relative to population are best exemplified by the Chemical Society, which has continued to represent an entire field of science, in striking contrast to the proliferation of biological societies. This difference may be considered in relation to the nature of the subject-matter and the historical sequence of discoveries, on one hand, and to the stability of the societies, on the other.

Rates of growth. In order to compare the rates of growth of the different groups of sciences, a sample was taken of those societies for which complete series of figures were available. From 1880 onwards rates of increase over decades, after correcting for changes in the population of Great Britain, are shown in Fig. 2. Fluctuations are more pronounced in the early parts of the curves because of the relatively small number of societies which were rapidly increasing in size.

The rate of growth of membership must be due to many influences. The most obvious of these are increase in population and opportunities for higher education, which doubtless enlarge the potential membership of societies.

The curves may be studied in the light of developments in the different groups of sciences and of

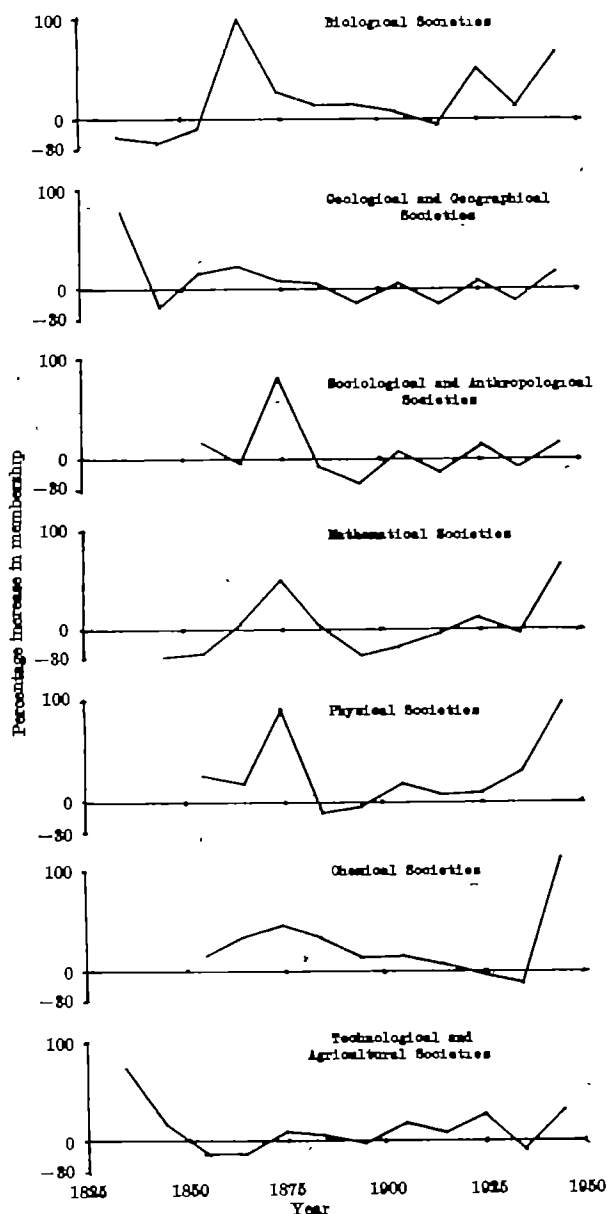


Fig. 2. Rates of growth of scientific societies after allowing for population increase

economic and social influences. For example, the large peak in the curve of the biological societies between 1860 and 1870 may possibly be associated with the publication of "The Origin of Species" in 1859. This peak is reflected to some extent in geology and geography. In the other groups of sciences a peak of growth occurs between 1870 and 1880. There is a marked difference in the effect on membership of the First and Second World Wars, respectively. There does not appear to have been a rapid increase in membership after the first war as there was after the second.

Interpretation of the Data

The collection and analysis of our data have been guided by the idea that the development of societies might show characteristics of growth similar to those displayed by cellular colonies or human populations.

In particular, the interesting analogies between mental and physical epidemiology, which Prof. L. S. Penrose^{1,2} was the first to draw, might lead one to expect that the growth in size of learned societies over a period of time might be susceptible to analysis in epidemiological terms. He has considered crazes, panic reactions and religious enthusiasms in the light of these analogies. The societies in our series might constitute extreme members of a class of much wider range. Intermediate members of this class might be represented by cults with pretensions to scientific status which grow rapidly and decline with the advance in knowledge as, for example, the twenty-nine phrenological societies, which once enjoyed a transient existence in Great Britain. At the other extreme are the mass phenomena of the Middle Ages, such as the Flagellant Movement and dancing manias.

The brief span of life of certain societies also characterizes certain journals. "The *Glasgow Medical Examiner* made two brief but fiery appearances with one volume published in 1831, the other in 1869. Its meteoric career was characterized on both occasions by its capacity for unrestrained vituperation against all established authority and institutions, a characteristic which, along with the yellow tint of its cover, earned for it the unofficial sub-title of 'The Mustard Plaster'. Its final taunt to its more dignified rival (the *Glasgow Medical Journal*) was a description of the article appearing there as 'a mass of clotted nonsense'."

Phases in the life of scientific societies may be expressed in epidemiological terms comparable with those identified by Penrose. First there is a latent period in which the idea of a society is germinating in the minds of one or more individuals. The second phase is an increasingly rapid growth of members.

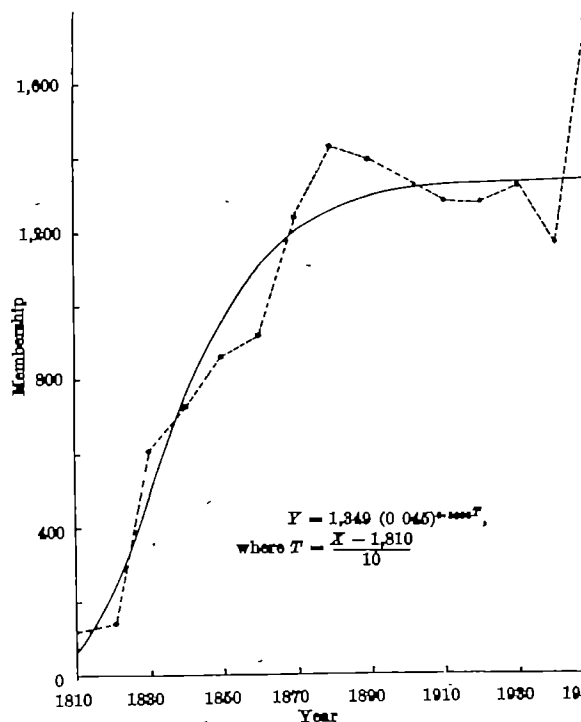


Fig. 3. Gompertz curve fitted to membership of the Geological Society

This is followed by a third phase in which the rate of growth is no longer increasing but remains fairly constant or even decreases. This may be due to exhaustion of potential membership, a factor analogous to saturation of the susceptible population in epidemiology.

During the fourth phase other influences enter, such as competing societies and shifts of scientific interest which produce immunity to the society's ideas in non-members and members alike. The development of immunity may be illustrated from the experience of one of us who joined a society about seven or eight years ago as a result of an acute 'infection' with the ideas of the society. At first the subscription was paid punctually without any prompting on the part of the society. After about three or four years, prompting was needed before the subscription was paid. At first prompting led to an immediate response. At the next stage more than one prompting became necessary and the delay became more prolonged. Eventually, the threshold of response became so high that the combined effect of several promptings was nil. There is now complete immunity.

Finally, during the fifth phase, the rate of attracting new members no longer offsets wastage from various causes. After this a society may disappear or recommence a new cycle of activity.

As might be expected, the development of learned societies seems to be subject to many more influences than is the course of an epidemic. For example, socio-economic changes and technological discoveries have a profound impact on the spread of scientific ideas and on the possibility of forming and maintaining an association.

We have fitted Gompertz curves to the figures of membership of a number of societies (without allowing for increase in population) and have found a reasonably close fit to the data. Fig. 3 shows this curve fitted to membership of the Geological Society. In the case of the Chemical Society the curve gives an excellent fit for the first eighty years of its existence. After 1920 the size of the Society fell below the expected values and at 1950 rose well above them. The curve may be used for representing stages in which a society is still growing and the size which it will reach if present conditions are maintained.

Supplementary studies and conclusion. Various independent estimates may be made of the extent of interest and development in the different fields of science in Great Britain. We have considered three types of data which could provide such estimates, namely: (1) the number of scientific journals of different kinds; (2) the number of patents sealed each year since 1852; and (3) the number of students of science in the universities.

Briefly, there seem to be two or three journals per thousand members. In the case of patents there has been a steady increase in the number sealed since 1850, comparable with the increase in membership of technological societies. During both World Wars, however, there was a distinct decline followed in each case by a recovery to the pre-war level.

The figures of university output of honours graduates in science represent perhaps the main source of potential membership of scientific societies. In 1951-52 as compared with 1925-26 the number of honours science graduates shows an increase of more than 200 per cent, advanced science students 150 per cent, and membership of societies 100 per cent.

Studies of this kind may be extended to professional, voluntary and reform societies. A special case is the growth of societies in a limited population, such as a university, where it is possible more readily to examine such problems as overlapping membership and intensity of participation. We have undertaken such an inquiry at Manchester. These studies lend themselves to elaboration on comparative lines at different levels, institutional, urban and national. For example, a comparison might be made of student life at two or more universities, or two cities might be compared with respect to the number and variety of societies of different kinds.

If size of membership of scientific societies is an index of scientific effort, the upward trend which is at present so characteristic of the figures of membership holds out promise of significant developments in the future. The trend perhaps entitles us to take a rozier view of British science in the decade ahead than recently expressed forebodings might lead one to expect.

¹ Penrose, L. S., "On the Objective Study of Crowd Behaviour" (London: H. K. Lewis, 1952).

² Cohen, John, *Nature*, 170, 474 (1952).

Note. The quotations in the text are in nearly every instance taken from the literature of the societies.

INDUSTRIAL METHODS OF STERILIZATION

PROBLEMS associated with "Industrial Methods of Sterilization" were discussed on January 13 at a symposium meeting in London organized jointly by the Society for Applied Bacteriology and the Microbiology Group of the Society of Chemical Industry.

The first speaker, Dr. M. Ingram (Cambridge), discussed "Sterilization with Ozone". Ozone is widely used for air and water sterilization and for the preservation of foods, including meats and vegetables. It should be remembered that the power of penetration of ozone under such conditions is limited, and hence disinfection can take place only in the surface. The mode of action of ozone as a disinfecting agent is not understood; but it is known that it produces ozonides which in turn hydrolyse, giving rise to acid products; it also reacts with amino-acids to produce

aldehydes and hydrogen peroxide. The efficacy of disinfection is therefore dependent on the nature of the material to be treated; but exact information on the influence of various factors concerned is lacking, and much of that available is contradictory. Disinfection is not achieved in time periods of seconds, as is apparently popularly imagined, but requires several minutes. A reciprocal time-concentration relationship appears to exist, provided an initial basic concentration of about 1 p.p.m. is allowed. The presence of organic matter tends to extend the disinfecting lag-period, and a similar lag occurs where the ozone concentration is low or where surfaces are being treated.

Relative humidity plays an important part in air disinfection, for increasing values above 50 per cent result in increased activity. With solutions, the

effect of pH is difficult to measure because of the acid products of reaction, which themselves can be inhibitory to bacterial growth. Different opinions are expressed on the effect of temperature, some authors stating that it is slight or negligible, while others find that reduction of temperature below 20° C. tends to give increased efficacy. These differences may possibly be due to errors in the methods of analysis of the ozone as well as to impurities present or to products of ozone reaction. Oxides of nitrogen, for example, which can be present in large proportions depending on the method of preparing the ozone, can exert a considerable enhancement in disinfecting efficiency.

Although the popular belief is that canned foods are virtually sterile, this is not the case in practice according to Mr. Osman Jones (London), who discussed "The Survival of Bacteria in Wholesome Canned Foods". He pointed out, for example, that foods of low pH value are adequately preserved by a mild heating to kill moulds, any bacteria present being incapable of development owing to the acidity. Meat products are seldom sterile in the proper sense: up to 25 per cent of certain tinned meats have been found to contain bacteria, and Savage has put this figure, in some cases, as high as 100 per cent. Tinned meats have been kept organoleptically sound for several years, although containing viable bacteria, one of the most notable examples being that of a tin of meat brought back from the Parry Arctic expedition which, on opening after 113 years, yielded six different strains of bacteria. Pork has been inoculated with *Clostridium sporogenes* and, after heat treatment, has been stored at 37° C. for long periods without showing any deterioration, in spite of the survival of small numbers of the inoculated organisms. Sudden reactions, however, have been known to take place after relatively long periods of storage, and these may be due to slow internal reactions such as nitrite-nitrate changes. Environment affects, considerably the heat resistance of bacteria, and spore-formers are found to be more resistant in cooked meat than in raw material, and again more resistant if protected by fats. The reason why organisms should remain dormant for long periods is, at present, obscure.

Discussing the "Sterilization of Surgical Dressings", Dr. R. Maxwell Savage (London) directed particular attention to the different properties of superheated and supersaturated steams, stating that the former is inefficient as a sterilizing agent unless the temperature is raised to that for normal dry-heat sterilization. He illustrated diagrammatically how in steam autoclaves the normal sterilizing temperature and pressure could be attained either by a saturated steam cycle, as is usually carried out, or by a superheated steam cycle, in which case sterilization may not be properly achieved. Considerable care is necessary to eliminate air so far as possible as this tends to layer in the autoclave and also to give rise to 'superheated' steam, and so reduces the efficiency of sterilization. It also tends to layer around the surfaces of objects being sterilized and prevent full access of the steam. Moreover, air is always being introduced into the system via the steam mains supply, hence the need of adequate venting of the autoclave is apparent.

Contrary to expectations, dressings wrapped and sealed in paper present no difficulty in sterilizing. This is presumably because there is sufficient moisture in the dressings to provide steam to saturation point.

Similarly, dry-heat sterilization of sealed packets can be achieved more readily in closed than open packets, again due to the small amount of steam generated through the seal. Dr. Savage agreed that air-venting of dressing drums is most important, and that there are good arguments for eliminating metal containers entirely. He also thought that one effect of superheated steam is to dry off the organisms and so render them heat-resistant.

Mr. G. Sykes (Nottingham) dealt mainly with the "Sterilization of Air" as required on a large scale for antibiotic fermentations. He pointed out that sterilization by chemical means is impracticable because of the danger of the carry-over of the disinfecting material into the fermentations, and that heat treatment, although very efficient, is again impracticable on a large scale on economic grounds. Ultra-violet radiation, although suitable for many purposes, is unsuitable in this case because of its limited efficiency both in terms of time and of its inability to deal with bacterial spores and protected organisms. The precipitron, likewise, had not proved sufficiently effective in service.

Mr. Sykes then discussed the various filter materials which are commonly used in practice, and showed that both granular and fibrous materials can be used. Efficiency of filtration depends on various factors, including the size of the air-borne particles to be removed, the size of the granules or fibres of the filter, the electrostatic properties of the filter and air flow-rate, and this was demonstrated with filter materials such as alumina, glass wool, steel wool and slag wool. These findings bear out the various theories of air filtration. A coarse granule or fibre filter is less effective than a finer one, and the packing density of fibrous filters is significant; increase of air flow-rate gives a more efficient filtration. Of the various materials tested, slag wool, as previously reported by Cherry and colleagues, was found to be the most efficient. With this material at a suitable packing-density, even after prolonged continuous use, organisms have rarely penetrated beyond about 3 in.

These papers will be published in full in the *Journal of Applied Bacteriology*, copies of which are obtainable through the Society for Applied Bacteriology.

OBITUARIES

Prof. R. W. Wheldon

PROF. ROBERT WILLIAM WHELDON died on January 15, shortly after collapsing in his office in the School of Agriculture, King's College, Newcastle upon Tyne. His death is a severe loss to the University of Durham and to the many agricultural interests with which he was connected. He was widely known as a scientist, a farmer and a public servant.

Robert Wheldon was born in the county of Durham on January 17, 1893. He was a farmer's son and as such entered Armstrong College as a short-course student, having received his school education at Rutherford College. In this course, he showed his considerable ability and went on to take a degree in agriculture, graduating in 1915. He was immediately appointed by his professor, Douglas Gilchrist, to the teaching staff of the Department of Agriculture, and he afterwards served this Department, first as lec-

turer with Prof. Gilchrist and his two successors, and later as professor.

From the early age of eighteen he farmed on his own account and at the time of his death he occupied some seven hundred acres of farm-land in County Durham. Here, his pedigree herd of Jersey cattle hold an international reputation. However, his main endeavour was in the fields of agricultural teaching and research. His academic career was substantially influenced by his early training under Gilchrist, at a time when the experimental work at Cogle Park on grassland improvement was becoming world famous. As a member of the staff of the Agricultural Department, and later as director of the Cogle Park Station, he was responsible, in a very practical way, for much of the improved grassland husbandry techniques since applied to farming. His first personal contribution to agricultural research, however, was connected with the manuring of the potato crop, and he obtained his D.Sc. in 1927 as a result of this work. The period 1940-53 represents a time of considerable development of agriculture within the Newcastle Division of the University of Durham. Prof. Wheldon used all his wide knowledge and experience untiringly for the furtherance of agricultural education and research. At the beginning of the War, while still a lecturer, he was appointed acting head of the Department, and gave it fresh life. He was awarded a personal professorship in 1943 and was formally appointed as professor of agriculture and rural economy in 1947. In that year, the Department of Agriculture was enlarged to a School of Agriculture with its own faculty within the University, and with Prof. Wheldon as its first dean. In 1944, the University acquired the tenancy of a 742-acre farm at Nafferton for use as a teaching farm, and in 1945 took over Cogle Park Experimental Station from the Northumberland County Council. The numbers of students and postgraduate workers increased tenfold under Prof. Wheldon's leadership.

His skill and experience were used outside the University in the application of scientific developments to farming practice, and he played a leading part in both technical and administrative work in agriculture in the North of England. During the war period, he served with the Durham County Agricultural Executive Committee and was appointed chairman of this Committee in 1952. In addition, from September 1952 he represented the Minister of Agriculture as his personal liaison officer in the Northern Province. He undertook this work although he knew full well that by doing so he was adding to the risks of ill-health.

Prof. Wheldon was a past president of the English Jersey Cattle Breeders' Society and vice-president of the newly formed World Jersey Cattle Bureau—an organization created in no small measure by his personal efforts. His old students knew Prof. Wheldon as a great friend and an inspiring teacher. Through them, his influence on the science and practice of agriculture will go on in many ways. He was a modest man and a great Christian, who enriched the experience of all who worked with him. Above all, he will be remembered by his colleagues and friends in a very personal way, especially for his kindness and wise counsel.

J. S. HALL

Prof. H. Benndorf

DR. HANS BENNDORF, professor emeritus of physics in the University of Graz, Austria, died on February

11, 1953. He was born in 1870 at Zurich and was the son of the well-known archaeologist, Otto Benndorf. He studied mainly in Vienna, and he was appointed lecturer in the University there in 1899. During 1904-36 he was professor of physics in the University of Graz, where the Institute of Physics was, under his direction, a place of many-sided scientific investigations. Both the many students of physics and his colleagues knew him as a rigorous and critical yet kind-hearted teacher, always willing to give them assistance.

Of the scientific investigations of Benndorf, those in atmospheric electricity and seismometry are the best known and they were of great importance for further investigations. The Benndorf quadrant electrometer for registering the electrical field in the atmosphere is known throughout the world. Many other problems of pure physics, too, were dealt with at Graz under the guidance of Benndorf; for example, problems of the propagation of electrical waves, examination of luminescence and piezoelectricity, and measurements of ionization in electrical discharges. The great number of investigations at Graz directed by Benndorf was made possible by his genius for experimentation with limited resources, as there was little money in the Institute of Graz.

Benndorf's books and his theoretical papers, too, are distinguished by clarity of style, and he advised his co-workers to follow his example with regard to this. In the preface to the first volume of *Physica Acta Austriaca*, which came out in 1948 under Benndorf's stimulation, he urged young physicists to give a clear exposition of their work. Benndorf had the results of his investigations published only when he was absolutely sure of them, for he believed that physicists working in the same field should not have to study unnecessary literature.

The scientific work of Benndorf was acknowledged by his election as a member of the Academy of Sciences in Vienna in 1929.

Benndorf married his cousin, Rosa Wagner, daughter of the well-known political economist Adolf Wagner, of Berlin; they had four children. The eldest, Wolfgang, was until recently librarian in the University of Graz. His daughter Nora emigrated with her husband, a medical man, to the United States. Two of Benndorf's sons were reported missing in the Second World War.

Benndorf corresponded with many friends throughout the world and he also visited them, for he loved travelling. He was an ardent player of the viola in his leisure time, and was an excellent mountain climber. His strength of character and warmth of heart gave support and consolation to many in times of political stress.

A. SZÉKELY

We regret to announce the following deaths:

Mr. A. Campbell, one of the original members of the staff of the National Physical Laboratory, on February 6, aged ninety-one.

Prof. Kotaro Honda, formerly of the Tohoku Imperial University, known for his work on magnetism and in metallurgy, on February 12, aged eighty-three.

Mr. David Milne, C.I.E., formerly economic botanist to the Government of the Punjab, and during 1923-33 dean of the faculty of agriculture, Punjab University, Lahore, aged seventy-seven.

NEWS and VIEWS

Organic Chemistry at Belfast: Prof. R. A. Raphael

DR. RALPH ALEXANDER RAPHAEL has been appointed to the recently created professorship in organic chemistry in The Queen's University, Belfast. Part of Dr. Raphael's schooldays were spent at Wesley College, Dublin. He graduated from the Imperial College of Science and Technology, London, in 1941 with first-class honours, and was awarded the Ph.D. degree in 1943. During the years 1943-46 he took part in the Anglo-American co-operative research on penicillin, as a departmental head in the Chemotherapeutic Research Division of Messrs. May and Baker, Ltd. He returned to the Imperial College in 1946 with an Imperial Chemical Industries research fellowship, and proceeded in 1949 to Glasgow to the post he now holds as lecturer in organic chemistry. He was awarded the Meldola Medal in 1948. The main course of his research work has entailed the study of the properties of acetylenic compounds, especially in their deployment as synthetic tools for a wide range of organic compounds of biological importance. Successful syntheses during the course of this work include penicillinic acid, histamine, linoleic acid, 2-deoxyribose, and the rare branch-chain sugars, spiose and cordycepose. Dr. Raphael's devising and carrying out of numerous ingenious and original syntheses of a wide variety of near-biological compounds gives promise of much important research work in the future. His investigations have been published in some forty research publications. He is also the author of significant contributions on alicyclic chemistry to the series of text-books on the "Chemistry of Carbon Compounds", and has been occupied in researches on tropolones. The capacity Dr. Raphael has already shown of teaching organic chemistry to students and of imparting enthusiasm for research should find fresh scope in the development of the School of Chemistry at Belfast.

John Innes Horticultural Institution: New Director

DR. K. S. DODDS, who has been appointed director of the John Innes Horticultural Institution, Bayfordbury, Herts, in succession to Prof. C. D. Darlington, is a botanist with wide knowledge of economic plants and particular interests in the field of cytogenetics bearing on their evolution. After graduating at Armstrong College, University of Durham, he spent some time in Indiana State University as the holder of an Earl Grey Memorial Fellowship, and in 1937 joined the staff of the Imperial College of Tropical Agriculture in Trinidad. There he became interested in the breeding of bananas and devoted most of his research time for the next ten years to cytogenetical problems in *Musa*, with outstanding success in elucidating breeding behaviour in that complex and important group. He visited the Western Pacific on an official mission in 1945, and in 1947 was appointed professor of botany in the College, adding research on cacao and other tropical crops to his duties. Dr. Dodds left tropical agriculture in 1949 to take charge of the Commonwealth Potato Collection at Cambridge, now the Agricultural Research Council's Potato Genetics Station. At Cambridge his researches on potatoes and related species have been, like his earlier studies of bananas, chiefly directed to explaining breeding behaviour in a crop plant of complex genetical history.

American Association for the Advancement of Science: Awards

THE Prize Committee of the American Association for the Advancement of Science announced during the recent annual meeting that the twenty-sixth Newcomb Cleveland Prize of 1,000 dollars had been awarded to Prof. Barry Commoner for his paper entitled "Studies on the Biosynthesis of Tobacco Mosaic Virus". Prof. Commoner is professor of plant physiology at the Henry Shaw School of Botany, Washington University, St. Louis, Missouri, and for some years he has been studying the changes in the metabolism of tobacco leaves produced by infection with tobacco mosaic virus. His results have led him to conclude that virus formation starts from simple ammonia compounds, and that the developing virus does not incorporate amino-acids and other intermediates that already exist in cells at the time they become infected. He considers that synthesis occurs in a series of steps, and that the virus nucleic acid is made first, to be followed shortly by a range of proteins that are not identical but are all serologically related to the infective virus. Prof. Commoner and his colleagues have previously shown that tobacco mosaic virus can be prevented from multiplying in tobacco leaves by treating the leaves with thiouracil or certain other analogues of pyrimidines and purines.

The ninth Theobald Smith Award in Medical Sciences for 1953, comprising 1,000 dollars and a bronze medal, has been awarded by the Association to Dr. Irving M. London, of the College of Physicians and Surgeons, Columbia University. This award was established in 1936 by Eli Lilly and Company. Dr. London received the award in recognition of his significant contributions in the fields of porphyrin, cholesterol, and protein metabolism. He has studied the life-span of the red blood cell in normal and pathological states, such as sickle cell anaemia, polycythemia vera, and pernicious anaemia. Using isotopic tracers, he has developed a technique for the study of antibody formation in surviving tissue. This provides not only a method for studying the capacity of individual tissues to form antibodies, but also a controlled system for the study of protein synthesis *in vitro*.

Declassification of Atomic Information

As a result of the recommendations made by the sixth Tripartite Declassification Conference held at Chalk River, Canada, during April 8-10, 1953, amendments have been made to the Declassification Guide used to decide what atomic energy information may be published and what must remain secret. Dealing with reactors, a major difficulty in formulating policy has been that no sharp dividing line can be drawn between such power-producing reactors and reactors for plutonium production or military purposes, and indeed designs have been discussed for dual-purpose reactors for producing power and plutonium. It was agreed that while information of critical importance for the design or operation of reactors for plutonium production or military purposes must still be kept secret, information required for studies of the economics of power reactors should so far as possible be released. Up to the present, all work in production establishments, such as the Windscale and Capenhurst works, has been treated as classified. It has been agreed that many of the less important details and processes can now be released, while maintaining secret the production

technology of substances of critical importance to the project. However, in the case of heavy water and graphite production and the reduction of uranium compounds to metal, it has been agreed that some of the older production processes can now be declassified. All information on the neutron cross-sections of carbon and graphite has been declassified. The spontaneous fission-rate of plutonium-240 has been declassified. As a result of previous conferences, values for the thermal neutron cross-sections of uranium-235, uranium-238, natural uranium and plutonium-239 were released. It has now been agreed that the cross-sections may be published in the ordinary way, together with experimental details of the method of measurement. Much of the basic chemistry of plutonium has already been declassified. It has now been agreed that some of the physical properties that are related to the metallurgy of pure plutonium can also be released. Basic chemical studies involving the use of ion exchange resins for all elements except plutonium can be released, as can basic studies on the chemical kinetics of fluoride corrosion. Information can now be released on the production of fission products as sources of radiation for industrial and medical purposes.

Scientific Requirements of Pakistan

At the Sixth Pakistan Science Conference, held in Karachi during January 18-23, the presidential address was given by Dr. M. Raziuddin Siddiqi, vice-chancellor of the University of Peshawar, who chose as his subject "Scientific Research in the East". After referring to the fact that the early development of all sciences owed much to the scholars and savants of the East, who at the dawn of history were both leaders and sole workers in all branches of knowledge, Dr. Siddiqi affirmed that freedom of inquiry and freedom of expression are the two essential conditions for any kind of intellectual activity. Learning and scholarship thrive, he said, only where and when the true democratic spirit prevails, and the neglect of these conditions has been an important factor in the decay of scientific activity in the East during the past few centuries. Another factor has been the distortion of values and lack of appreciation of intellectual achievement: even now it is not generally recognized that education and research are as essential elements in national defence as armed forces, and that scientific education and research have their place in any long-range defence plan.

The immediate problem for Pakistan, Dr. Siddiqi continued, is not so much that of providing mechanics, technicians or science teachers as to produce the experts and research-workers of the highest standard who can discover and develop its natural resources, build up new industries, and design and instal the plant required. An intensive search for talent among students is required and, when found, the prospective experts and investigators should be given a much longer training than is at present customary. Status and remuneration also require attention, and good work in the scientific and technical field should be sure of ample recognition. Adequate provision should also be made for fundamental research, and this is a matter of equipment as well as of personnel. Apart from strengthening the research work at the universities, well-planned and equipped scientific academies and research institutes are required, and it is also desirable to remedy the failure of the existing organization for research to produce the apparatus and

equipment essential for research purposes. Dr. Siddiqi emphasized that Pakistan cannot always rely on other countries for the supply of the essential tools of research.

Plankton Studies

It is a matter of common observation that plankton is very unevenly distributed in the sea and, moreover, frequently it appears to be the case that any one patch may consist almost entirely of phytoplankton while another is mainly zooplankton. Two principal theories, not mutually exclusive, have been put forward to account for this. One, associated with the name of Harvey, is that the zooplankton would graze down a patch of phytoplankton, increasing correspondingly in numbers as it does so, until the phytoplankton is used up, and this would be followed by the dying off or migration of the zooplankton, leaving a more or less free area in which the phytoplankton could once again forge ahead. The other, associated with the name of Hardy, suggests that a high concentration of phytoplankton in some way actually repels the zooplankton and keeps it from invading the area. Richard Bainbridge (*J. Mar. Biol. Assoc.*, 32, 385; 1953) has approached the whole problem from the experimental angle. Several ingenious pieces of apparatus made of rectangular 'Perspex' tubes, including a circular channel 4 ft. in diameter with an internal diameter $2 \times 1\frac{1}{4}$ in., made it possible to follow the migration of plankton, horizontally and vertically, under controlled conditions. An arrangement of sliding water-tight doors and admission points allowed of the setting up of phytoplankton gradients and the subsequent introduction of zooplankton. On the whole, using a fairly wide range of organisms, the evidence obtained favours the 'grazing' hypothesis, but with active and directive migration, both horizontal and vertical, playing a larger part than perhaps had been envisaged previously. In initial experiments it was found that none of the diatoms used, with the possible exception of *Nitzschia* in very high concentration, showed a toxic or excluding effect.

Activity of Fungi In Dried Soil

In relation to the very considerable work now in progress both in the fields of antibiotics and plant pathology, it is essential that fungal cultures can be stored for considerable periods of time without losing their pristine physiological properties; in particular, their pathogenicity and their ability to produce particular substances under specified conditions. In a recent paper, R. G. Atkinson (*Canad. J. Bot.*, 31, 5, 542; 1953) has reviewed some of the methods which have been used for storing fungal cultures and has contributed new data on the survival and pathogenicity of *Alternaria raphani* after five years in dried soil culture. Soil cultures of *Alternaria raphani*, a seed-borne pathogen of radish, that had become dry when four to six weeks old, were still viable after five years. The incidence of residual viable centres in cultures of four of the five wild types studied was much higher than in those of their respective variants, on the basis of colony counts from platings of 5-gm. samples diluted one-fifth. The reverse of this was true for the remaining wild type and its variant. This pair was also unique in that the wild type had been shown to possess little infectivity, whereas its variant had proved to be highly virulent. The fungus showed no change in cultural characteristics after its five-year

period in dry soil, nor any loss of virulence when plants of radish, stock and wallflower were inoculated.

Royal Astronomical Society: Officers for 1954-55

At the annual general meeting of the Royal Astronomical Society, held on February 12, the following officers were elected for 1954-55: *President*, Dr. J. Jackson; *Vice-Presidents*, Miss Flora M. McBain, Prof. W. H. McCrea, Prof. H. H. Plaskett and D. H. Sadler; *Treasurer*, Prof. L. M. Milne-Thomson; *Secretaries*, Prof. C. W. Allen (University Observatory, Mill Hill Park, London, N.W.7) and Dr. A. Hunter (Royal Observatory, Greenwich); *Foreign Secretary*, Prof. F. J. M. Stratton.

Mineralogical Society of Japan: Officers

THE following have been elected officers of the Mineralogical Society of Japan. *President*: Zyunpei Harada (Hokkaido University, Sapporo); *Secretaries*: Keiichi Omori (Tohoku University); and Toshio Sudo (Tokyo University of Education). *Treasurer*: Bumpai Yoshiki (Research Laboratories of the Asahi Glass Co.). *Editors*: Nobuo Katayama (*chief editor*), Teiichi Ito, Seitaro Tsuboi and Takeo Watanabe (University of Tokyo); Zyunpei Harada (Hokkaido University); Keiichi Omori (Tohoku University); Jitsutaro Takubo (University of Kyoto); and Toyofumi Yoshimura (Kyushu University). The Society was formed at an inaugural meeting held in the University of Tokyo on June 30, 1952. Its objects are to promote the study of mineralogy and related sciences and to bring together Japanese workers engaged in mineralogical research. Two series of publications are issued as official organs of the Society: *Kobutsugaku Zasshi* (*J. Min. Soc. Japan*), of which Nos. 1, 2 and 3 were published in September 1952, January 1953 and May 1953, respectively; and *Mineralogical Journal*, first published in September 1953).

University of Birmingham

THE following have been appointed lecturers in the University of Birmingham: Dr. J. Hardwicke (experimental pathology) and Dr. J. B. Finean and Dr. W. F. R. Pover (pharmacology). The title of University Research Fellow has been conferred upon the following during the tenure of their posts as research workers in chemistry: Nadim A. Ghanem, Dr. Herbert A. Laitinen, Dr. W. G. P. Robertson, Dr. W. Brock Neeley and G. Vaughan. The following have resigned from the University: Dr. B. A. Pethica, lecturer in pharmacology, on his appointment as lecturer in the Department of Colloid Science, University of Cambridge; and G. D. Mitchell, lecturer in sociology, on his appointment as lecturer in charge of the sub-department of sociology, University College of the South-West of England, Exeter. The Gas Council has established three research scholarships, tenable for a period of three years, in the University Department of Chemical Engineering; one scholarship will be awarded each year. An expedition to the Sahara desert is being organized by Dr. E. B. Edney, reader in entomology, Department of Zoology and Comparative Anatomy, and Dr. J. Kolbuszewski, lecturer in the Department of Civil Engineering. Dr. Edney will study the ecology of desert arthropods, and Dr. Kolbuszewski will continue his studies on the wind deposition of sands. Another expedition is being made this year, the purpose of which is to study stratigraphy and paleont-

ology in west Spitsbergen, and is being organized by Mr. P. A. Garrett, lecturer in the Geology Department, in conjunction with the University College of the South-West of England, Exeter. The University of Birmingham has made grants of up to £500 to each of these two expeditions in order to defray expenses. The Huxley Lecture of the University will be given in the Chemistry Theatre, Edgbaston, at 5 p.m. on March 5, by Dr. D. M. S. Watson, formerly Jodrell professor of zoology and comparative anatomy in University College, London.

Nuffield Foundation Awards in Dentistry, Biology and the Social Sciences

THE Nuffield Foundation is offering a number of fellowships, scholarships and bursaries in the fields of dentistry, biology and social sciences as follows. The fellowships for dentistry are for persons, aged 25-35 years, with dental qualifications, to receive additional training in pure and applied science so as to undertake an academic career in dentistry, and also to enable graduates in medicine or science to receive training (not necessarily for a registrable dental qualification) that will fit them for teaching and research in dental health and disease; the fellowships are worth £500-800 a year for one to three years, and applications must be received by March 1. Dental scholarships, normally for one year only, are available for students at university dental schools in the United Kingdom and cover tuition fees and a subsistence allowance of not more than £200; applications must be received by June 30. The Foundation's scholarships and bursaries in biology and the social sciences are for graduates of British universities, preferably within the age-group 22-35 years. The awards in biology are for persons who have graduated in physics, chemistry, mathematics or engineering, but who have had no training in a biological subject, and who wish to receive such training in biology as will enable them to undertake research and teaching in the United Kingdom in biological sciences. The scholarships are for persons with some previous experience in postgraduate research in their own subject and are worth £500-800 a year (plus tuition fees); the bursaries are for those who have recently graduated and are worth £350 a year (plus fees). In both cases a marriage allowance of £50 a year and £50 for each of the first two children will be paid. Applications must be received by April 1. The awards for the social sciences are similar to those for biology, except that applications must be received by May 1 and the holder may have a degree in any subject other than the social sciences, psychology or economics; subjects suitable for study are political science, social psychology, anthropology, social statistics and sociology generally (but not economics). Application forms for all these awards and further information can be obtained from the Secretary, Nuffield Foundation, Nuffield Lodge, Regent's Park, London, N.W.1.

Semiconductors: Conference in Amsterdam

THE Netherlands Physical Society, with the support of the International Union of Pure and Applied Physics and the United Nations Educational, Scientific and Cultural Organization, is organizing an international conference on semiconductors, to be held in Amsterdam during June 29-July 3. The subjects to be discussed will include bulk recombination, surface conductivity, surface trapping, surface recombination, intermetallic compounds, the

band picture in polar and non-polar semiconductors, photoconductivity in semiconductors (such as lead sulphide, lead telluride, lead selenide, zinc sulphide and cadmium sulphide) and the application of general physical and chemical laws for the preparation of semiconductors with specific properties. During the mornings, main lectures, with time for discussion, will be given and the subjects will be considered in more detail during the afternoons, when sectional meetings will be held and brief contributions of 10-15 minutes in duration may be read. The official languages of the conference will be English, French and German. The conference is open to all, without fee, on application to the secretary, Dr. H. J. Vink, Floralaan 142, Eindhoven, from whom further information can be obtained.

Tenth International Congress of Agricultural and Food Industries, Madrid

THE Tenth International Congress of Agricultural and Food Industries, arranged under the auspices of the International Commission of Agricultural Industries, will be held in Madrid during May 30-June 6. Besides reviews and discussions of a wide variety of general problems in world agriculture, food and agricultural industries, studies will be made of a number of special, or specially processed, foodstuffs. The International Commission is an inter-governmental organization, meeting once or twice a year, the purpose of which is to study scientific, technical and economic questions directly or indirectly affecting the food, agricultural and biological industries in various countries. Its headquarters are at 18 Avenue de Villars, Paris 7°. Further information regarding the Congress in Madrid can be obtained from the General Secretary of the Tenth International Congress of Agricultural and Food Industries, Zurbano 3, Madrid.

Postgraduate Course at Salford on Chromatography

A POSTGRADUATE course on both the theory and practical aspects of chromatography will be held in the Royal Technical College, Salford, during September 13-17. The lecturers will include Drs. A. J. P. Martin and R. R. Porter (Medical Research Council), Dr. S. M. Partridge (Low Temperature Research Station, Cambridge), Mr. C. S. G. Phillips (Oxford), Dr. B. A. J. Lister (Harwell), Mr. R. A. Wells (Department of Scientific and Industrial Research), Drs. A. A. Levi and R. R. Goodall (Imperial Chemical Industries, Ltd.) and Dr. G. R. Barker (University of Manchester). The fee for the course will be £4 4s. Application forms and further information can be obtained from Dr. E. G. Edwards, Royal Technical College, Salford.

Announcements

MISS PHYLLIS BARCLAY-SMITH, secretary of the International Committee for Bird Preservation, has been awarded the Gold Medal of the Sveriges Djurskyddsföreningars Riksförbund in recognition of her work for bird protection and especially with regard to the prevention of oil pollution of the sea. The Medal was presented to her by the Swedish Ambassador on February 9.

THE Aberdeen Section and the Food and Agriculture Groups of the Society of Chemical Industry, jointly with the Scottish Branch of the Institute of Biology, will hold a conference on "New Develop-

ments in the Utilization as Food of Fish and Agricultural Products and their By-products" in Aberdeen during September 30-October 2. Details of the papers to be read and the visits which are being arranged will be published in due course.

APPLICATIONS are invited for grants from the Clough Memorial Research Fund of the Edinburgh Geological Society for geological research in Scotland and the north of England (Northumberland, Durham, Cumberland, Westmorland and Yorkshire) during April 1, 1954-March 31, 1955. The Fund was founded in 1935 for the purpose of encouraging geological research and about £30 is available annually. Applications must be sent before March 31 to the Secretary, Clough Memorial Research Fund Committee, Edinburgh Geological Society, Synod Hall, Castle Terrace, Edinburgh 1, from whom further information can be obtained.

Two scholarships, tenable at research institutions in France during the academic year 1954-55, are being offered to British workers in medical science, excluding clinical medicine, by the Medical Research Council on behalf of the Centre National de la Recherche Scientifique. They are intended for young graduates in medicine or science who have already had some experience in a branch of medical science and are worth 50,000-70,000 francs a month, with a supplementary allowance, payable in sterling, for married men. A working knowledge of the French language is essential. Application forms, to be returned by March 31, and further details can be obtained from the Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

THE Mond Nickel Fellowships Committee is offering a number of fellowships, open to persons of British nationality with degree or equivalent qualifications, so that they can obtain wider experience and additional training in industrial establishments, at home or abroad, in order to make them more suitable for future employment in senior technical and administrative positions in British metallurgical industries. Each fellowship will cover one full working year and will be worth £900-1,200. There are no age limits; but awards will seldom be made to persons more than thirty-five years old. Application forms, to be completed by June 1, and further information can be obtained from the secretary, Mond Nickel Fellowships Committee, 4 Grosvenor Gardens, London, S.W.1.

THE Royal Anthropological Institute has arranged six public lectures, which began on February 16 with an address by Prof. H. J. Fleure on "The English Heritage: its Study and Demonstration". The remaining five lectures will be given at fortnightly intervals on Tuesdays at 2.30 p.m. in the meeting room of the Royal Society of Arts (6 John Adam Street, London, W.C.2), the next one being on March 2. The respective subjects and speakers will be: anthropological aspects of blood-group studies in Britain (Dr. J. A. Fraser Roberts); the rural community (Prof. Adam Curle); ploughs in Britain (F. G. Paine); the importance of custom in industrial society (H. N. C. Stevenson); and the application of anthropological knowledge to our industrial society (Sir Robert Hyde). Each lecture will be followed by discussion. Admission is free. All inquiries should be directed to the Royal Anthropological Institute, 21 Bedford Square, London, W.C.1.

ELECTRON MICROSCOPY GROUP OF THE INSTITUTE OF PHYSICS

ANNUAL CONFERENCE

THE annual conference of the Electron Microscopy Group of the Institute of Physics was held in Birkbeck College, University of London, during November 10-11. The Group held its meetings in the lecture theatre of the Physics Department, and was welcomed by Prof. J. D. Bernal, head of the Department.

Papers covering the electron microscope and a wide range of its applications were read. The first paper of the conference was presented by M. E. Haine and T. Mulvey (Associated Electrical Industries, Aldermaston) on the correction of astigmatism in electron lenses. They have analysed the edge diffraction test of Hillier and Ramberg¹, showing that it is sufficiently sensitive to allow adequate correction to obtain 10 Å resolution, and they described the design and application of a four-pole cylindrical stigmator lens.

Several papers were presented covering chemical applications of electron microscopy, one of which, by E. Crampey, Dr. M. Gordon and J. W. Sharpe (Royal Technical College, Glasgow), described an electron microscope study of the hydrochlorination of natural and synthetic polyisoprene. Miss K. Little (Medical Research Council Radiobiological Research Unit, Harwell) described how the electron beam energy could manifest itself as heat and as a source of ionizing radiation, and she showed some changes in appearance of plastics which had been bombarded by electrons from a Van de Graaff generator. Miss J. M. Peckett then described a method used in the Mechanical Engineering Research Laboratory, East Kilbride, for specimen preparation of soap fibres present in alkali base greases, whereby oil is vaporized *in vacuo* to leave the soap fibres unchanged in size, shape and arrangement for viewing in the electron microscope; the specimens are used in research into the function of the structure of a grease in the lubrication of roller bearings.

Reports of work done with the reflexion electron microscope were presented by the Laboratory of Physics and Chemistry of Surfaces, University of Cambridge, and the Research Laboratories of the Associated Electrical Industries, Aldermaston. Dr. J. W. Menter and his colleagues at Cambridge described work on synthetic and other fibres, electrodeposits and the polish on diamonds, while Dr. J. F. Halliday (Aldermaston) examined the finish of surfaces prepared by typical engineering methods, such as grinding, polishing, lapping, etc., and also worn surfaces. Some advantages of the technique are that asperities making an angle of $\frac{1}{2}^\circ$ or less with the horizontal can be observed, and also the surface structures (such as electrodeposits) are more easily identifiable than by replica or light microscopical techniques.

A short note on some recent results of X-ray microscopy in the United States was presented by Dr. S. P. Newberry (General Electric Co., Schenectady, N.Y.) and Dr. W. C. Nixon (Cavendish Laboratory, Cambridge). Resolution using magnetic electron-beam focusing lenses was up to twenty times better than for electrostatic lenses. Micrographs obtained with magnetic focusing showed resolution of the order of 1 μ . Among the metal-

lurgical results an aluminium-tin alloy (5 per cent tin) 0.020 in. thick showed the deposition of tin to be along the aluminium grain-boundaries.

Dr. V. E. Coslett (chairman of the Electron Microscopy Group) and M. E. Haine (Associated Electrical Industries, Aldermaston) gave a report of the electron microscopy conference held in Innsbruck during September 16-19, 1953. This was followed by a comprehensive report by D. E. Bradley (Associated Electrical Industries, Aldermaston) on the development of a new technique for producing strong specimen-supporting membranes and also replicas of high resolution. To make the supporting films, carbon is evaporated *in vacuo* by passing a high current between two pointed carbon rods mounted so that the points are lightly held together. The evaporated carbon is allowed to fall on to the surface of glass, from which it may be stripped and mounted on specimen grids in the usual way. It may also be evaporated on to the surface of glycerol or plastic. In the latter case the plastic is dissolved away after the composite film is on the grid. To make the replicas two methods have been developed. For examining photographic grain, carbon is evaporated directly on to the emulsion, floated free on the surface of water, and mounted for the electron microscope. For metal surfaces, a plastic replica is made in the accepted manner, carbon deposited on the replicating surface, the composite replica mounted on a grid, and finally the plastic dissolved away. The carbon replica may be shadowed if desired. The carbon films produced in this way withstand the electron beam better than plastic and are more transparent to the beam. Some research done with this method was presented by J. F. Nankivell (Cavendish Laboratory, Cambridge) and E. Smith and Dr. J. Nutting (Metallurgy Laboratory, Cambridge) which supported Mr. Bradley's claim of high resolution. Dr. C. E. Challice (Wright-Fleming Institute of Microbiology, London) described how he had used the method for backing thin biological sections.

Unexpected aspects of the polystyrene-silica replica technique experienced at the Shirley Institute, Manchester, were described by S. F. Ward and Dr. D. G. Drummond. They showed that although silica, when evaporated on to the polystyrene, covers the whole surface, it remains thinner in the lee of a projection than elsewhere, producing a 'self-shadowing' effect. This effect was also shown by Mr. Bradley in his carbon replicas. A method for examining selected areas of surfaces using wet-stripped replicas was described by G. R. Booker (Metropolitan-Vickers Electrical Co., Ltd., Manchester). The selected area of surface is identified by fine scratches in the immediate vicinity, and the corresponding portion of the replica is mounted over a hole 0.015 in. in diameter in a copper disk. It is viewed in the electron microscope using a specimen screening aperture. Application of the anodic replica technique to the study of the structure of cast aluminium-manganese alloys was described by Miss M. K. B. Day (British Aluminium Co., Ltd.).

The biological session was opened by Dr. G. Eaves (School of Medicine, Leeds), who made some remarks

on the attainment of high resolution from thin tissue sections, and suggested that, to attain a resolution of 10 Å, the section must be 100 Å. or less in thickness. A short discussion followed in which Mr. Haine (Associated Electrical Industries, Aldermaston) stated that, to avoid graininess in the final photographic print due to random fluctuations in the electron beam, a 10-Å. resolution micrograph must be recorded on the photographic plate at a magnification of not less than $\times 50,000$. R. C. Valentine and Dr. J. R. G. Bradfield (University of Cambridge) then presented two papers, in the first of which they described how, by draining the suspending fluid from a drop of suspension on a collodion-covered grid, damage to bacterial cells can be minimized. In their second paper they described preliminary observations on 0.085- μ sections of *Staphylococcus aureus* and *Paracolon bacillus*. Bodies described as resembling chromosomes were shown in the nucleus, which was demonstrated to contain deoxyribonucleic acid by use of a modified Feulgen stain.

Dr. T. H. Flewett and Dr. G. Eaves (School of Medicine, Leeds) showed sections of egg membranes infected with vaccinia virus, ultra-thin sections of the vaccinia virus being demonstrated. Dr. E. M. Brieger and Dr. A. M. Glauert (Strangeways Laboratory, Cambridge) showed some sections of lung and spleen of mice infected with bovine tubercle bacillus.

Mrs. B. E. Williams reported that the National Physical Laboratory, Teddington, has developed a cheap method of producing gelatin copies of diffraction gratings, from which it is possible to make 'Formvar' replicas for the electron microscope for use in magnification calibration. The Laboratory is prepared to supply these copies at a nominal charge to cover postage and packing. C. E. CHALLICE

¹ Hillier, J., and Ramberg, H. G., *J. App. Phys.*, 18, 48 (1947).

NORTHERN SECTION OF THE PHILOSOPHY OF SCIENCE GROUP INAUGURAL MEETING

AN inaugural meeting to constitute the Northern Section of the Philosophy of Science Group of the British Society for the History of Science was held in the Staff House, University of Manchester, on January 30, at 2.30 p.m. Despite the cold weather, which made travel difficult, it was attended by representatives from the Universities of Leeds and Liverpool and the University College of North Staffordshire. Of those from the University of Manchester, eleven departments were concerned—botany, child health, classics, chemistry, extra-mural, mathematics, philosophy, psychology, radio astronomy, theoretical physics and zoology. From Leeds the departments represented were mathematics, medical physics and philosophy; from Liverpool, philosophy and zoology; and from North Staffordshire, philosophy and physics.

After Prof. L. Rosenfeld (professor of theoretical physics, University of Manchester) had been elected chairman of the business meeting, Dr. W. Mays (University of Manchester) gave an account of how the proposal for a Northern Section arose. He pointed out that for a number of years it had been felt by some members of the Philosophy of Science Group

who were living in the North of England that they were missing a good deal by not being able to attend its meetings, and it was therefore considered appropriate to have a Section of the Group in their part of the country. Such a Section would help to bring together people interested in the philosophy of science and encourage discussion and research. Inquiries made at Leeds, Liverpool, Sheffield and North Staffordshire as well as Manchester showed that there was considerable interest in the proposal. The members promoting the scheme therefore decided to ask the Philosophy of Science Group for permission to form a Northern Section, and this was readily granted. As far as future activities are concerned, it is hoped to hold meetings at regular intervals at the various university centres taking part in the scheme. There will obviously have to be a good deal of flexibility and decentralization, and, wherever possible, local centres will be encouraged to organize their own activities.

The resolution to form the Section was then put to the meeting and carried, and it was decided to elect a provisional committee to take charge of affairs until October, when there will be a general meeting and officers will be elected for the year 1954-55. Prof. D. M. Emmet (professor of philosophy, University of Manchester) was elected provisional chairman of the Section, and Dr. Mays provisional honorary secretary and treasurer. It was resolved that the committee be composed of two representatives from each University, and that members should be elected by the Philosophy of Science Group on the recommendation of the Section. Twenty-eight applications for membership were made at the meeting.

Prof. L. Rosenfeld then gave a lecture on "Rationalism in Antiquity". The topic, he said, has philosophical as well as scientific implications. If one examines the atomic theory of Democritus, one is struck by the modernness of his approach as he seriously attempts to give a rational explanation of the universe devoid of theological or mythological content. The view has been advocated that the growth of rational thinking in Ancient Greece, which led to the birth of Ionian natural philosophy, was to some extent conditioned by the social and economic changes occurring at the time. During the Pre-Socratic period the Greeks had the East opened up to them for trading purposes. In some ways one is reminded of the growth of scientific ideas during the sixteenth century as a result of navigational discoveries.

With the breakdown of Athenian democracy and its subsequent domination by Alexander, Greek philosophy lost its flexibility and became rapidly systematized. A new type of literature developed, the writing of Utopias with their veiled criticism of the authorities. The seeds sown by free discussion among the earlier Greek thinkers became, in Alexandrian times, Stoicism and Epicurianism; but whereas Democritus represented an optimistic and constructive philosophy, Epicurus and Lucretius represented a philosophy of pessimism fighting against a decaying civilization.

But the ideas of the Milesian thinkers were not entirely original. The first international carriers and merchants were the Phoenicians. If the philosophical thought of the Phoenicians was purely mythological in character, the hypothesis that there is a relationship between rationalism and commercial adventure becomes considerably weakened. The little that is

known of Phoenician cosmology would seem, however, to indicate that it too was rationalistic in character. Though this resemblance between Phoenician and Greek thought may have been solely due to their both being seafaring nations engaged in commerce, one cannot entirely rule out the possibility that the former had some influence on the latter.

W. MAYS

BRITISH GELATINE AND GLUE RESEARCH ASSOCIATION

RESEARCH PANEL MEETING

THE seventh meeting of the Research Panel of the British Gelatine and Glue Research Association was held at Beale's Restaurant, London, N.7, on November 26, with the director of research, Mr. A. G. Ward, in the chair.

The meeting took the form of a symposium on soluble collagens, the salient points under discussion being outlined in a general introduction, given by Dr. R. H. Smith (Biophysics Unit of the Medical Research Council). The remaining speakers then gave more detailed accounts of the progress made and conclusions reached in studies made using specialized techniques. Dr. R. W. G. Wykoff (science attaché to the American Embassy, London) reviewed the evidence for the conclusion that the fine structure of reconstituted collagen fibrils, as revealed by electron micrographs, depends upon the conditions for reprecipitation (for example, the pH and the precipitating agent). At present, four kinds of order may be produced, only two of which (with spacings of 640 Å. and 210 Å.) have been seen in native collagen. The remaining forms are fibrils with a spacing greater than 2000 Å. and segmented fibrils.

Dr. F. C. Kelly (Biophysics Unit of the Medical Research Council) described in some detail experiments on the production of segmented material by adding nucleotides (such as adenosine triphosphate) to solutions of alkali-soluble collagen, prepared by extracting rat skin with secondary sodium phosphate.

The preparation and properties of the materials obtained by the reconstitution of citrate-extracted calf skin, acid-extracted tendon and alkali-extracted calf skin were discussed by Dr. J. H. Bowes (British Leather Manufacturers' Research Association). Amino-acid compositions, determined by Moore and Stein's procedure, were compared with that of native ox-hide collagen. These results are of particular significance to the manufacturer of gelatine, who normally pre-treats the raw material under acid or alkaline conditions.

Dr. D. S. Jackson (Rheumatism Research Centre, Manchester) gave an account of recent work on the evaluation of the relative importance of ionic and hydrogen bonds in determining the stability of rat-tail tendon. About one-quarter of the stability appears to arise from ionic linkages between collagen and chondroitin sulphuric acid, the main mucopolysaccharide present in tendon.

An extensive investigation, using human abdominal subcutaneous connective tissue, has led to the conclusion that this tissue contains at least three acid polysaccharides, none of which is identical with chondroitin sulphate. Dr. R. Consden (Special Unit for Juvenile Rheumatism, Maidenhead) described the work leading to this conclusion, and Dr. J. E.

Eastoe (British Gelatine and Glue Research Association) mentioned that he had found similar complexity in the mucopolysaccharides in the ox-femur shaft.

The important question of how collagen fibres arise within living tissue was discussed by Dr. S. Fitton Jackson (Biophysics Unit of the Medical Research Council), who paid attention particularly to the evidence obtained from phase-contrast microscopy and electron microscopic studies on the ossification of embryonic cartilage in the chick.

The final topic for discussion was high-angle X-ray diffraction in collagen. Mr. A. O. T. North (Wheatstone Physics Laboratory, King's College, London), after indicating the difficulties associated with obtaining reconstituted collagen in a form suitable for X-ray diffraction work, discussed the information which has been obtained from diffraction diagrams of swollen rat-tail tendon. Such diagrams are typical of a helical rather than a sheet-like structure for collagen. Dr. P. M. Cowan (also of the Wheatstone Physics Laboratory) elaborated on this conclusion, mentioning the requirements of bulk density and the importance of proline residues in connexion with hydrogen-bonding and stereochemical considerations. The helical structures proposed by various authors for collagen have been examined by the optical diffraction pattern method, and none appears satisfactory.

ARAB NATIONS SCIENCE CONGRESS IN ALEXANDRIA

A SCIENCE congress for the Arab nations, arranged by the Arab Nations Organization, was held in Alexandria, for the most part in the Faculty of Commerce of the University of Alexandria, during September 1-8, 1953, under the presidency of Prof. Mostafa Naxif, vice-rector of Ibrahim University, Cairo. More than five hundred men of science attended, representing Egypt, Iraq, Jordan, Lebanon, Palestine, Saudi Arabia, Syria and Yemen. The congress was opened by the president of the Republic of Egypt, General Neguib, who, with the official delegates from the nations participating, gave short speeches in which they stressed the importance of scientific co-operation among the Arab nations.

The activities of the congress were grouped into three sections. The first section, on original researches, consisted of about sixty papers dealing with mathematics, astronomy, physics, meteorology, biology, geology and chemistry; these papers were read before three groups, each of which held four meetings. Full details of these researches will be published in a special book to be issued by the organizing committee of the congress. At the second section, on general scientific problems, the subjects discussed dealt with scientific terminology; editing, translating and publishing books; the training and equipment of science teachers for schools; and the importance of science to the national economy. The organizing committee for the congress had previously arranged for the discussion of these problems by forwarding questionnaires to members of the teaching staff in the universities and ministries of education in the participating nations, and the replies had been published in book-form and circulated to members of the congress before meeting. The Arabic language was strongly recommended for the teaching of science in universities, and encouragement of the publication

of scientific books was stressed. The third section of the congress was devoted to general cultural talks, and the subjects dealt with in this section mainly comprised the history of science in the Arab nations, such as progress in mathematical and navigational sciences, by Kazwini, Ibn El Haytham, Khawarizmi, El Tousy, El Bayrouni, El Battani, Ibn Sena, Gaber Ibn Hayan and others.

During the congress, exhibitions were arranged: one dealing with modern materials organized by the United Nations Educational, Scientific and Cultural Organization, another with the history of science in the Arab nations, and a third with scientific books written in Arabic and other languages. The congress also arranged for visits to places of scientific interest, such as the Institute of Marine Biology at Alexandria, the Roman Museum, the Misr Company for Cotton Weaving, the Misr Company for Artificial Silk, and the Burg el Arab field for desert plants. Among the decisions made in the final meeting of the congress was a recommendation for the institution of an Arab Scientific Union to be initiated by the Arab Union Organization.

WATER POLLUTION RESEARCH

REPORT FOR 1952

THE report of the Director of Water Pollution Research and that of the Water Pollution Research Board are contained in an interesting publication entitled "Water Pollution Research 1952". It is not possible in a short notice to indicate all the interesting work that is being done on this important subject, and the reports themselves should be consulted.

Work has continued on the effect of various substances on the disinfecting action of chlorine on bacteria in water, and methods have been improved for the enumeration of *Streptococcus faecalis*, an organism which is one of the indicators of faecal pollution. Work has also been done on the removal of radioactive iodine discharged as a constituent of sewage in small amounts into streams after its use in medicine.

Work on sewage at Birmingham has confirmed that slow rotation of percolating filters lowers the biochemical oxygen demand of the effluent and considerably increases its nitrification. Other work on sewage has shown that a volume of filtering medium of 10 cubic yards for each 10-20 persons gives effluents of very good quality. Experiments done in co-operation with the Gas Board have shown that spent liquor from the gasworks at Hinckley can be treated in a percolating filter in admixture with sewage, in a concentration up to 3 per cent, by volume, without causing much deterioration of the quality of the effluent. This proportion is very much higher than that possible when gas liquor of the ordinary type is used. The methods used at Hinckley for the treatment of hot gas by electrostatic precipitation, with the object of reducing the concentration of higher tar acids in the liquor, are described. Further work on this subject is in hand.

Work has also been done on industrial waste waters. In the treatment of black liquor resulting

from the kieren of cotton, an active sludge has been developed which, when it is mixed with the neutralized liquor, causes rapid anaerobic fermentation with the evolution of gas containing about 80 per cent of methane. Experiments have also been done on methods of treating simple and complex metallic cyanides mixed with sewage. It has proved possible to obtain, from sewage containing potassium, zinc and cadmium cyanides in concentrations equivalent to a hundred parts of hydrogen cyanide per million, effluents which contained an average of less than 0.2 p.p.m. of cyanide. It has also been shown that the toxicity of potassium cyanide in small concentrations increases markedly as the concentration of oxygen in solution is reduced. This is important in the design of toxicity tests and in the effect on fish of toxic substances in rivers.

The largest section of the report discusses the work on the Thames Estuary. Among the subjects studied are the distribution of salt and fresh water, the effect of rough weather in raising the level of oxygen dissolved in the water, pollution by discharges of organic matter contained in streams, sewage effluents and industrial wastes, the particle size of deposits in the Estuary, the important effect of suspended solids on the biochemical oxygen demand of Estuary water, the inhibition by oxygen of bacterial reduction of sulphate to sulphide and the catalytic effect of mud in promoting oxidation of sulphide by oxygen in solution.

The presence of large quantities of foam in rivers has been reported from many places during the year, and work on this problem is contemplated. With regard to the problem of pollution of beaches by oil, investigations on methods of preventing this pollution, in which a number of oil companies are co-operating, is in progress. A special problem, not specifically mentioned in these reports, would seem to be the general effects of substances now being extensively used for the control of pests of crops. Since the end of 1952 *Water Pollution Abstracts*, published by H.M. Stationery Office, has issued 35,000 abstracts, and the size of this monthly publication was increased in 1953 to meet the large number of papers now being written in Britain and elsewhere on this subject.

THE COSMOTRON AT THE BROOKHAVEN NATIONAL LABORATORY

VALUABLE information concerning nuclear forces and the properties of fundamental particles can be obtained from the study of the interaction of high-speed nucleons with nuclear matter and from the interaction of individual nucleons. The energies required for the production of the lighter π -mesons and the heavier mesons are known from cosmic-ray investigations, and it has been the endeavour of many workers to produce such mesons in the laboratory by means of particle accelerators. Already during 1946-47 several particle accelerators capable of producing particles with energies of 300-400 MeV., sufficient for π -mesons, were under construction; but the design of accelerators for production of the heavier mesons requiring energies of the order of 5,000 MeV. had not been investigated.

*Department of Scientific and Industrial Research. Report of the Water Pollution Research Board, with the Report of the Director of Water Pollution Research for the Year 1952. Pp. iv+64+4 plates. (London: H.M.S.O., 1953.) 2s. 6d. net.

In 1947 the Brookhaven National Laboratory, Upton, New York, after careful consideration of the scientific, economic and practical factors involved, concluded that the proton synchrotron was the best type of accelerator suitable for the purpose, and in 1948, with the financial assistance of the United States Atomic Energy Commission, the design and construction of the cosmotron was commenced. The assembly took nearly four years, and in May 1952 a proton beam of 1,000 MeV. energy was obtained. This was increased to 2,000 MeV. in the following month, and with suitable modifications to the pole windings it is confidently expected that 3,000 MeV. will finally be obtained. Machines capable of reaching higher energies are being constructed elsewhere; but the cosmotron was the first high-energy accelerator to be constructed and to be operated.

The work was directed initially by M. Stanley Livingston (Massachusetts Institute of Technology), then by Milton G. White (Princeton University), and finally by G. B. Collins, who is the present chairman and who joined the project in April 1950. A detailed description of the principle, construction and operation of the cosmotron is given in a series of articles, edited by M. Hildred Blewett, a member of the cosmotron staff, in the special cosmotron issue of the *Review of Scientific Instruments* (24, No. 9; September 1953). L. J. Haworth, director of the Brookhaven Laboratory, contributes a short foreword, and this is followed by a general review, by the editor, of the cosmotron, discussed component by component and giving data concerning the personnel, cost and basic parameters.

A ring-shaped magnet guides the particles on a circular path of radius 30 ft., and a radiofrequency electric accelerating field provides increments of energy to the protons which are injected initially into the cosmotron, at about 3.5 MeV., from a Van de Graaff accelerator. The maximum magnetic field is 14,000 gauss. The vacuum is maintained by twelve 20-in. diffusion pumps at a minimum operating pressure of 5×10^{-6} mm. of mercury, and the volume evacuated is about 300 cu. ft. The other articles in the series are divided into sections dealing with the magnet, the pole-face windings, the radio-frequency system, the injection system, the vacuum system and the control system, respectively. Finally, three short papers deal with the cosmotron building, eddy-current phenomena and studies of injection phenomena in the cosmotron, respectively.

ALEURONE LAYER IN BARLEY

IN a comprehensive anatomical investigation of the aleurone layer in the cultivated barley, J. Sawicki (*Polska Akademia Umiejętności*, No. 66, 1-59, pub. Krakow, 1952, with English summary) has examined 103 varieties, representing all the sub-species of *Hordeum sativum* collected in different parts of the world.

In these materials, the number of cell rows in the aleurone layer and its thickness were observed. The range of variability of these characters was studied to see if they could be used in the classification of barleys. The hereditary transmission of these characters was also investigated over a period of several years. It has been ascertained that the varieties examined show distinct differences in regard to both the characteristics studied. The mean number

of cell rows in the aleurone layer of the different barley varieties ranges from 1.64 to 3.11, and the mean thickness of the aleurone layer from 49.94 to 110.16 microns.

Observations of the two characteristics in question on material from several years and from different climatic conditions showed that they exhibit a comparatively small variability due to the environmental conditions. A detailed analysis of variance of material of forty varieties from 1937, 1938 and 1947 cultures showed that as regards the number of the cell rows the varietal differences are responsible for 93.00 per cent of the total variation and for 85.60 per cent as regards thickness of the aleurone layer. The variation due to seasonal differences is very small: in the first case 0.60 per cent, and in the second 0.40 per cent of the total variation. The remaining amounts of variation are due to unknown causes (environmental changes). Similar results were obtained by analysis of the variation of the pedigree lines from 1947, 1948 and 1949, indicating that there are no essential differences between the pedigree lines and the examined material of commercial varieties. The results obtained justify the view that the aleurone characters are comparatively constant and may therefore be used in classification.

It is held that the results of these investigations corroborate the earlier data of Orlov, who found that barleys endemic in the Asiatic centre of origin as a rule possess three rows, and those of the African centre two rows, of cells in the aleurone layer only. As the European varieties of cultivated barley show a similar differentiation, the possibility exists of explaining, in some cases, their primary origin.

FORESTRY COMMISSION IN SCOTLAND

IN a small illustrated pamphlet entitled "The Forestry Commission in Scotland" (recently published by the Forestry Commission) it is stated that the history of forestry in Scotland is a long one. Shakespeare in "Macbeth", for example, brought the Birnam Woods to Dunsinane, a difficult military position, and timber from the same Birnam Hill in Perthshire was used for helping the national effort during the Second World War. Great natural woods once covered most of Scotland; but through the years, fire, disease and the axe took a great toll. Later, many of the remaining forests were exploited for charcoal for iron-smelting purposes, followed by the spread of sheep-raising at the end of the eighteenth century.

It was the great inroads into the woods of the country, almost entirely privately owned, during the First World War that brought the Forestry Commission under the Forestry Act of 1919. The Commission was reconstituted by the Forestry Acts of 1945 and 1951. Under the 1945 Act the Commission was made subject to direction from the Minister of Agriculture and Fisheries and the Secretary of State for Scotland. In Scotland all land acquired through the Forestry Fund is vested in the Secretary of State.

Between the World Wars a great deal of planting was done by the Forestry Commission, but the resultant plantations were still too young to provide any contribution of value to the timber requirements of the Second World War. Once again it was the

privately owned woodlands which were subjected to over-felling, no less than 344,000 acres being felled. In Scotland this war-time felling amounted to 155,000 acres, with the result that many a glen and mountain-side are now no longer recognizable.

In 1946 the Commission embarked on a big post-war programme, the aim of which is to produce five million acres of productive forests in Great Britain. This involves the development of three million acres of new forest mainly on moorland and mountain-side and other land of low agricultural value, and the restoration to full production by private owners and the Commission of two million acres of existing woodlands. It is proposed that not less than half the new planting will be carried out in Scotland, where there is a great deal of land eminently suitable to afforestation, this being done without any interference with land which can be utilized for agriculture, for agriculture has the first call on all land.

Planting is proceeding all over Scotland at a steadily increasing rate. During the 1951-52 season nearly 31,000 acres were planted by the Commission, whereas five years before only about 12,300 were planted. By 1956 it is hoped to increase the annual rate to forty thousand acres, about 40 per cent being in the Highland counties. The Commission has one million acres of land in Scotland, three hundred thousand acres of which is planted; the balance of the land is made up of areas still being grazed and awaiting afforestation, land given up to forest nurseries, unplantable land and mountain tops the forests of which come into the national forest parks, and lastly a considerable area which will remain permanent agricultural land. Among the species of tree used, Scots pine ranks high; but on the peaty slopes of the western hills, with their high annual rainfall, Sitka and Norway spruces are more satisfactory. Other conifers used are the three larches, European, Japanese and hybrid, the Corsican pine and the Douglas fir, the latter first introduced in 1826 from British Columbia by David Douglas. The area suitable for hardwoods is limited. Already the work entailed has resulted in an increase of population, and forest villages are in the process of being built. The afforestation campaign will add in the future very considerably to the wealth of Scotland, apart from the increase in employment provided by the forests and the connected wood industries.

E. P. STEBBING

DETERMINATION OF ATOMIC MASSES BY THE PYKNO-X-RAY METHOD

By PROF. T. BATUECAS

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IN a previous communication¹ it was shown that the atomic masses of various chemical elements can be calculated with precision by means of the pykno-X-ray method, when the density and X-ray data of the crystalline solid have been measured at the same temperature.

It is to be noted, however, that the method as described was not capable of the highest accuracy because the data used were slightly uncertain. In order to remedy this and at the same time to check

the accuracy of the new method, researches have been in progress since 1950 in this laboratory with the object of measuring the densities of several crystalline solids at the same temperature at which their grating spaces had been determined. It seemed useful to report the first results obtained for sodium chloride, arsenic trioxide (As_2O_3 , octahedral form), and silica (α -quartz), as well as the atomic masses deduced for sodium, arsenic and silicon. Further, we can add (1) another result for the atomic mass of silicon from the very precise data obtained at 20° C. by M. E. Straumanis and E. Z. Aka² for octahedral silicon, and (2) the value for the atomic mass of calcium calculated from the excellent measurements made on calcite also at 20° C. by J. A. Bearden³.

In our calculations of 1950, we adopted calcite as reference standard "because in our opinion its density, grating space and structural geometric constant have been determined with greater accuracy than any other crystalline solid". This was qualified by the remark that "Finally, it would be better to take as reference standard instead of calcite another such as diamond. Then, of course, the value used for the Avogadro number would be that deduced from diamond". In view of the recent beautiful work on diamond of M. E. Straumanis and E. Z. Aka⁴, it seems that the time has now come for adopting as standard this latter substance instead of calcite.

Actually, using the 'methode asymetrique' (probably the most exact method available at the present time for determining the grating spaces), Straumanis and Aka have succeeded in making highly accurate measurements on three specimens of very pure diamond between 10° and 50° C. From these data the grating space at 23.5° C. (all corrections made) $d^{23.5} = (3.55961 \pm 0.00001)_A$ Å, $d^{23.5} = (3.56882 \pm 0.00008)_A \times 10^{-8}$ cm., taking into account that to convert to absolute values the values expressed in the Siegbahn scale, multiplication by the factor (1.00202 ± 0.000015) is necessary. The temperature of 23.5° C. is that at which J. A. Bearden³ determined the density of diamond which seemed then to be the most probable value, namely, $\rho_{\text{diamond}}^{23.5} = (3.51836 \pm 0.00004)$ gm./cm.³.

In our opinion, the diamond is much better than calcite as a reference standard because the uncertainty in the molecular weight of the latter is much greater than that of the atomic weight of carbon. As already stated, in taking diamond as the reference standard the value for the Avogadro number used in the calculations must necessarily be that referred to diamond. Now the unit cell of the latter contains eight atoms of carbon and the formula to be used will be:

$$8 M_{\text{diam}} = N_A \cdot \rho_{\text{diam}} \cdot (d'_{\text{diam}})^3, \quad (1)$$

in which the symbols ρ_{diam} and d'_{diam} represent in our case the density and the grating space of diamond at 23.5° C. For the atomic weight of carbon we assume $C = (12.011 \pm 0.0006)$ in agreement with that recently found in this laboratory⁵ by means of the gas dimethyl ether $(CH_3)_2O$, namely, $C = (12.011 \pm 0.001)$ and identical with the value now considered as most probable by E. Wichers⁶. On substituting the appropriate data in formula (1), the value of the Avogadro number is found to be:

$$N_A = (6.0236 \pm 0.0006)_A \times 10^{23}$$

a result used in all the calculations of atomic masses in question here.

Sodium chloride. The pycnometric measurements made by M. Carreira at 18° C. in this laboratory, using our precision technique (slightly modified), on very pure sodium chloride—fused and carefully dried beforehand—gave for the density $\rho_{\text{NaCl}}^{18} = (2.16383 \pm 0.00005)$ gm./cm.³. By taking for the grating space the value determined at 18° C. by Y. Tu³, namely, $d_{\text{NaCl}}^{18} = (5.63978 \pm 0.00003) \times 10^{-8}$ cm., and since the unit cell of sodium chloride contains four pairs of ions, the formula is

$$4 M_{\text{NaCl}} = N_A \rho_{\text{NaCl}} \cdot (d_{\text{NaCl}}^*)^3, \quad (2)$$

from which $M_{\text{NaCl}} = (58.453 \pm 0.008_4)$ and on subtraction of Cl = 35.457, the atomic weight of sodium is $22.996 \pm 0.008_4$.

Arsenic trioxide (octahedral). Starting with As₂O₃ (Merck) and after very great care in purification, M. Carreira has obtained several measurements the mean of which gives for the density at 23° C. the value $\rho^{23} = (3.8685 \pm 0.0001_4)$ gm./cm.³. By taking for the grating space the value determined, also at 23° C., by Straumanis and Ievins⁵, namely, $d' = (11.0745 \pm 0.0001) \times 10^{-8}$ cm., and applying the formula:

$$8 M_{\text{As}_2\text{O}_3} = N_A \rho_{\text{As}_2\text{O}_3} \cdot (d'_{\text{As}_2\text{O}_3})^3, \quad (3)$$

one gets for the molecular weight of As₂O₃, (395.621 ± 0.061) and for the atomic weight of arsenic:

$$\text{As} = (74.905 \pm 0.015).$$

Silica (α-quartz). Using pure transparent quartz from de Noya (La Coruna, Spain), M. Carreira has made pycnometric measurements at 18° C. by means of the same refined technique. The general means of the measurements give for the density of silica (α-quartz) the value $\rho_{\text{SiO}_2}^{18} = (2.64875 \pm 0.00008)$ gm./cm.³. For the grating space we accept the values found by A. H. Jay¹² at 18° C., namely, $a = 4.9029$ Å. and $c = 5.8933$ Å., which in absolute measure are $a' = 4.9128 \times 10^{-8}$ cm. and $c' = 5.4042 \times 10^{-8}$ cm. Assuming the unit cell of quartz, of hexagonal structure, consists of nine molecules of SiO₂, the formula becomes:

$$9 M_{\text{SiO}_2} = 3 \cdot \sqrt{\frac{8}{3}} N_A \cdot \rho_{\text{SiO}_2} \cdot a'_{\text{SiO}_2} \cdot c'_{\text{SiO}_2}, \quad (4)$$

from which the atomic weight of silicon is

$$\text{Si} = 28.076.$$

The probable errors in M_{SiO_2} and Si are not given because the uncertainty in the values of the grating space a and c measured by A. H. Jay are not known.

Silicon (octahedral). The measurements recently carried out on pure crystallized silicon by M. E. Straumanis and E. Z. Aka⁴ have fixed with high accuracy the density and grating space of this element. The values found are $\rho_{\text{Si}}^{20} = (2.3283_1 \pm 0.00031)$ gm./cm.³ and $d_{\text{Si}}^{20} = (5.41991 \pm 0.00003)$ Å., which on the absolute scale is $d'_{\text{Si}}^{20} = (5.43089 \pm 0.00011) \times 10^{-8}$ cm. Since the unit cell of silicon (octahedral) contains eight atoms, the formula is

$$8 M_{\text{Si}} = N_A \rho_{\text{Si}} (d'_{\text{Si}})^3, \quad (5)$$

from which the atomic weight of silicon is

$$\text{Si} = 28.081 \pm 0.0073.$$

In view of the calculated probable error, this figure may be regarded as in agreement with the value obtained from silica.

Calcite. The measurements on pure calcite made by Bearden and by Bearden and Shaw⁶ allow the values at 20° C. of density, grating space and geometrical structural constant to be calculated to a very high degree of accuracy. The values are $\rho^{20} = (2.71030 \pm 0.00003)$ gm./cm.³, $d^{20} = (3.03567 \pm 0.00005) \times 10^{-8}$ cm. and $\varphi(\beta) = (1.09584 \pm 0.00001)$. Since the unit cell of calcite contains four pairs of ions, the formula for the calculation of molecular weight is:

$$4 M_{\text{CaCO}_3} = N_A \cdot \rho_{\text{CaCO}_3} \cdot \varphi(\beta) \cdot (d_{\text{CaCO}_3}^*)^3, \quad (6)$$

from which $M_{\text{CaCO}_3} = (100.105 \pm 0.017_4)$, and subtracting CO₂ = 60.011 ± 0.0005, the following figure is obtained for the atomic weight of calcium:

$$\text{Ca} = (40.094 \pm 0.017).$$

These results, in our opinion, show clearly that the pykno-X-ray method, in its new form, must now be ranked as one of the methods of precision for the determination of the atomic masses of the chemical elements. It is true that the possible errors in the method can sometimes become fairly large, as is the case with calcium. At the same time, it may be emphasized that this would only be the case if, in absence of all compensation, the errors were all in the same direction and hence cumulative. Usually at least a partial compensation takes place, so that in general the errors affecting the results furnished by the pykno-X-ray method will be rather small.

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² Straumanis, M. E., and Aka, E. Z., *J. App. Phys.*, **33**, 230 (1962).

³ Bearden, J. A., *Phys. Rev.*, **38**, 2080 (1931). Bearden and Shaw, *Phys. Rev.*, **48**, 18 (1935).

⁴ Straumanis, M. E., and Aka, E. Z., *J. Amer. Chem. Soc.*, **73**, 5543 (1951).

⁵ Bearden, J. A., *Phys. Rev.*, **54**, 654 (1938).

⁶ Batuecas, T., and Casado, F. L., *Am. Real. Soc. Exp. Fis. Quím.*, **B**, **46**, 535 (1952).

⁷ Wlobers, H., *J. Amer. Chem. Soc.*, **74**, 2448 (1952).

⁸ Tu, Y., *Phys. Rev.*, **40**, 602 (1932).

⁹ Straumanis, M. E., and Ievins, B., "Die Präzisionsbestimmung von Gitterkonstanten nach der asymmetrischen Methode" (Berlin, 1940).

¹² Jay, A. H., *Proc. Roy. Soc., A*, **142**, 237 (1933).

INCORPORATION OF 8-AZAGUANINE INTO NUCLEIC ACIDS

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8-AZAGUANINE, which differs from guanine in having the carbon atom at position 8 replaced by nitrogen, inhibits the growth of certain bacteria, fungi, algae, protozoa, animal tumours, and some plant and animal viruses. Some evidence has been presented¹ that, in certain of these cases, 8-azaguanine

can be recovered from acid hydrolysates of the ribonucleic acids, and in one instance⁴ there is indirect evidence for the presence of the compound in a nucleotide fraction. The isolation of a compound only as the free base from nucleic acids is not conclusive evidence of its incorporation, for we have frequently observed that ribonucleic acid preparations from tissues treated with 8-azaguanine, and even from viruses isolated from treated host plants, may be contaminated with small amounts of free 8-azaguanine. Only in the case of tobacco mosaic virus⁵ has it been conclusively shown, by isolation of material with the expected properties of 8-azaguanilyc acid, that 8-azaguanine is incorporated into the nucleic acid.

We have now isolated a compound with the properties of 8-azaguanilyc acid from alkaline hydrolysates of ribonucleic acids from the following after treatment with 8-azaguanine: *Bacterium coli*, *Staphylococcus aureus*, mouse liver and spleen and mouse sarcoma S 37 (in both the solid subcutaneous and the free-growing ascites forms).

B. coli strain 'B' was grown on a synthetic medium⁶ and two purine-less mutants of *B. coli* were grown on the same medium supplemented with minimal amounts of guanine. *Staph. aureus* was cultivated on a synthetic medium supplemented with small amounts of 'Marmite'. 8-Azaguanine was added to the media in concentrations between 100 and 150 µgm./ml. The bacteria were washed in 0.14 M sodium chloride, defatted and dried. Ribonucleic acid was extracted in M sodium chloride at 100°, deproteinized, and hydrolysed in N potassium hydroxide for 18 hr. at 37°.

Mice inoculated subcutaneously with sarcoma S 37 were injected intraperitoneally with two daily doses of 85 mgm. 8-azaguanine/kgm. body-weight, commencing five days after inoculation and continuing for five to seven days. Mice inoculated with sarcoma S 37 in the ascites form (where the cells grow freely suspended in the abdominal cavity) were similarly treated. Twenty-four hours after the last injection, the animals were killed, and the tumours, livers and spleens collected. In each case, livers, spleens and tumours were also taken from untreated tumour-bearing mice. 'Ribonucleoprotein' and 'deoxyribonucleoprotein' fractions were extracted from the tissues⁷. Ribonucleic acid was prepared by extraction of the 'ribonucleoprotein' fraction with M sodium chloride at 100°, partially purified and hydrolysed in N potassium hydroxide.

The methods used for the separation and identification of 8-azaguanilyc acid have already been described⁸. 8-Azaguanilyc acid isolated from alkaline hydrolysates of ribonucleic acid by paper electrophoresis at pH 9 was further characterized: (1) by chromatography in the ammonium sulphate-water solvent which separates the material into two spots corresponding to 8-azaguanosine 2' and 3' phosphates; (2) by hydrolysis in N hydrochloric acid at 100° to give a product with the chromatographic properties of 8-azaguanine; (3) by the ultra-violet absorption spectra of 8-azaguanosine 2' and 3' phosphates and the base obtained from them after acid hydrolysis. The ribonucleic acid obtained from 8-azaguanine-treated *B. coli* hydrolysed with snake venom diesterase and 5'-nucleotidase contained a substance with the expected properties of the nucleoside, 8-azaguanosine.

Table 1 gives the approximate amounts of 8-azaguanilyc acid found in the various ribonucleic acids.

Table 1. APPROXIMATE 8-AZAGUANILYC ACID CONTENTS OF RIBONUCLEIC ACIDS FROM ORGANISMS TREATED WITH 8-AZAGUANINE

Source of ribonucleic acid	Moles 8-azaguanilyc acid/100 moles ribonucleotides
<i>Bacterium coli</i>	0.2-0.5
<i>Staphylococcus aureus</i>	> 0.5
Mice bearing subcutaneous tumour (S 37)	
spleen	0.15-0.2
liver	0.2-0.4
tumour	0.05-0.1
Mice bearing ascites tumour (S 37)	
liver	none detected
tumour	0.15-0.2

With the purine-requiring mutants of *B. coli*, increasing the amount of guanine in the medium considerably decreased the incorporation of 8-azaguanine. We have confirmed that 8-azaguanine inhibits the growth of *B. coli*.

Although a substantial amount of 8-azaguanilyc acid was isolated from the liver ribonucleic acid from animals bearing subcutaneous tumours, none could be detected in liver ribonucleic acid from animals with ascites tumours (Table 1). Possibly the flow of lymph into the abdominal cavity which accompanies the development of the ascites tumours restricts the absorption of 8-azaguanine into the general circulation. The higher 8-azaguanine content of ribonucleic acid from ascites tumour cells compared with that from subcutaneous tumour cells is presumably due to the ascites tumour cells being in direct contact with much higher concentrations of the compound.

Treatment of animals bearing the subcutaneous form of the S 37 sarcoma with 8-azaguanine resulted in a delay of tumour growth, particularly during the first days of treatment. Livers and spleens from the treated animals showed no macroscopic changes, and histological examination revealed no signs of degeneration.

Tumours developed in all five control animals inoculated with the ascites form of S 37, but only in four out of the seven animals treated with 8-azaguanine. In these the mitotic rate of the tumour cells was reduced and the final volume of tumour cells per animal was about 40 per cent that of the controls.

Evidence has been given that particles of tobacco mosaic virus containing 8-azaguanine incorporated into their ribonucleic acid are non-infectious⁹, so it seems likely that the growth inhibition in bacteria and animal tissues may be largely due to the synthesis of biologically inactive ribonucleic acid containing 8-azaguanine. The results of Carlo and Mandel¹⁰ would not be inconsistent with this view. They found that 8-azaguanine had no significant effect on the incorporation of carbon-14 labelled guanine or 4-amino-5-imidazolecarboxamide into the nucleic acids of liver or sarcoma S 37 of mice. Any compound such as the riboside or nucleotide of 8-azaguanine which might be incorporated more readily than 8-azaguanine itself into ribonucleic acids will be of interest, particularly in systems such as tumours and viruses where growth inhibition is a desirable end.

We have attempted to detect 8-azaguanine in the deoxyribonucleic acid of liver, spleen and the tumours from mice treated with 8-azaguanine, and in that of *B. coli* 'B' and its bacteriophage T₂⁺ grown in the presence of 8-azaguanine. The purines were liberated from deoxyribonucleic acid by hydrolysis in N hydrochloric acid at 50° and separated by chromatographic and paper electrophoretic techniques which would

have allowed the easy detection of 8-azaguanine. In no case was this observed.

While we cannot exclude the possibility that the 8-azaguanine may be incorporated into deoxyribonucleic acid in amounts too small to be detected by our methods, there are structural considerations which may make its incorporation unlikely. In the Watson and Crick⁴ model of deoxyribonucleic acid, the keto form of the 6(OH) group of guanine forms an essential part of the hydrogen-bonded structure. The pK of the 6(OH) group in 8-azaguanine is 2-3 pH units below that of guanine⁵, so that at physiological pH values the percentage of molecules not in the keto form would be considerable. [Dec. 10.]

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ESTIMATION OF ZINC IN BIOLOGICAL SPECIMENS

Determination of Zinc-65

THERE is evidence that zinc is necessary for animals and plants; but information about the physiological role of this metal is scant. The enzyme carbonic anhydrase, present in red blood cells and certain other tissues, contains zinc as an integral part of the protein molecule¹; but little is known about the way in which zinc is combined in other animal tissues. In recent years considerable interest has been shown in the distribution of this metal in various tissues. It has been shown, for example, that human leucocytes contain two zinc-containing protein complexes², that some of the zinc in tumour tissue is loosely bound to nucleoprotein in the cell nuclei³, and that zinc in egg yolk is firmly bound to the protein part (vitellin) of lipovitellin⁴.

The use of a radioactive isotope of zinc (⁶⁵Zn) has greatly facilitated recent studies on zinc metabolism, and when radioactive zinc of high specific activity becomes more generally available, it is expected that there will be an increasing need for comparatively simple methods for measuring the amount of zinc-65 in tissues. In our own investigations we are using three different methods, and the following brief outline of these methods may be helpful to others who contemplate using it for biological investigations. A more complete account will be given elsewhere.

(1) *Quick, wet combustion method.* This method, a simplified version of method (2), involves the heating of a weighed amount of the tissue (for example, 0.1-5 gm.) with concentrated nitric acid or concentrated sulphuric acid (2 ml. per gm., with a minimum of 1 ml.) until a clear solution is obtained. When sulphuric acid is used, selenium dioxide (about 5 mgm. per ml.) should be added as a catalyst, and the digest can then be used for a total nitrogen determination. (Sulphuric acid has a further advantage over nitric acid in this respect, for acid fumes from the diluted nitric acid digest may cause corrosion of the counting equipment.) The acid digest is diluted

with water to a standard volume (for example, 15 or 20 ml.) and the radioactivity of 10 ml. of this solution is measured in a Veall-type⁵ counter for liquids.

We have found that under these conditions no correction for self-absorption is normally required, and the method gives complete recovery of zinc-65 added (as zinc chloride) to animal tissues or present in the tissues of animals previously injected with the isotope.

(2) *Extraction method.* Where there is a possibility that the material to be analysed contains significant amounts of radioactive isotopes other than zinc-65, some method of extracting the zinc from the digested tissue should be adopted. The tissue should be completely digested by long heating with an acid mixture, ammonia added to bring to pH 8.5-9.0, and the solution repeatedly shaken with a solution of dithizone in carbon tetrachloride to extract the zinc. The zinc in this zinc-dithizone solution is then extracted by dilute hydrochloric acid, and the radioactivity of this acid solution measured directly in a Veall-type counter.

This method is laborious, and it involves considerable manipulation and transference of solutions, with a loss of 3-5 per cent of the zinc-65.

(3) *Scintillation counter method.* Recently we have been using a scintillation counter for measuring the amount of zinc-65 in tissues, and, as we had expected (mainly from consideration of the decay scheme of zinc-65), this method proved to have several advantages over those which involve the use of a Geiger counter. Since the scintillation counter measurements are entirely concerned with the γ -radiation of this isotope, the preparation of the tissue for the determination is simple. Radioactivity measurements can be made on the homogenized tissue or on the solution obtained by heating the tissue with sulphuric acid as in method (1), and no self-absorption correction is required.

Table 1 gives a few typical results obtained with tissues (mouse liver and mammary gland) to which zinc-65 had been added (as zinc chloride) or which had been removed from mice previously injected with the isotope. In these particular experiments the tissues were first subjected to short acid digestion, to permit comparable determinations to be made with a Geiger counter, and scintillation counter measurements were made on 3-5 ml. of the diluted digest.

The results of these and many similar experiments have shown that for zinc-65 determinations the scintillation counter has a much greater sensitivity and consistency than has the Geiger counter. Furthermore, long acid digestion of the tissue is not required. Recently, we have found the scintillation counter method most helpful for determinations of the zinc-65 content of the faeces of hens which have been injected with the isotope, for direct measurements

Table 1. COMPARATIVE COUNT-RATES FOR ZINC-65 IN ANIMAL TISSUES WHEN MEASURED WITH SCINTILLATION COUNTERS (SC) AND GEIGER-MÜLLER COUNTERS (GC) FOR LIQUIDS (TYPE M6)

Tissue (No.)	Gross count-rate (counts per min.)		Background count-rate (counts per min.)		Ratio (net count-rate of sample/background count-rate)	
	SC	GC	SC	GC	SC	GC
1	28,200	1,008	209	18	90	55
2	7,500	228	315	15	23.6	18.9
3	1,290	57	322	16	8.0	2.6
4	512	23	315	16	0.6	0.4

can be made on the homogenized faeces. Wherever cross-checks have been made, the results obtained with the scintillation counter have been identical with those obtained with methods (1) and (2) above.

These investigations have been carried out with the aid of grants from the British Empire Cancer Campaign and the Medical Research Council, and we are also indebted to Prof. P. B. Moon and Prof. W. E. Burcham for the arrangements under which we were able to obtain irradiated copper target bars from the Birmingham cyclotron. The activated sodium iodide crystal used for the scintillation counter was supplied by the Atomic Energy Research Establishment, Harwell, and we are grateful to Dr. Denis Taylor and Mr. R. B. Owen for their help in this matter.

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Separation of Radioactive Zinc from Cyclotron-Irradiated Copper

THE chemical separation of radioactive zinc of very high specific activity from cyclotron-irradiated copper usually presents considerable practical difficulties on account of the minute amounts of total zinc which have to be separated from relatively large amounts of copper.

In the method described here, the irradiated copper target, which has usually been plated with spectrum-pure copper before irradiation, is arranged as the anode of an electrolytic cell containing 100 ml. of dilute sulphuric acid (about 4 N). Any parts of the surface of the target which are not to be brought into solution are protected by a coat of varnish. A copper-foil cathode is used, and a potential difference of 1 volt is applied. Electrolysis is continued until almost all the zinc-65 has been removed from the target, the solution in the cell being changed several times during this process. Each radioactive solution obtained is evaporated to dryness and the residue dissolved in an *n*-butanol-hydrochloric acid mixture (96 volumes of redistilled *n*-butanol to 4 volumes of constant-boiling hydrochloric acid). This solution is transferred to a cellulose-powder chromatography column (Whatman's ashless filter-paper powder), and the metals eluted with the same solvent mixture. Under these conditions, zinc moves rapidly down the column and is completely eluted before the visible green band, due to cupric chloride, approaches the bottom of the column. The radioactive eluates from each electrolysis fraction are pooled and the solvents

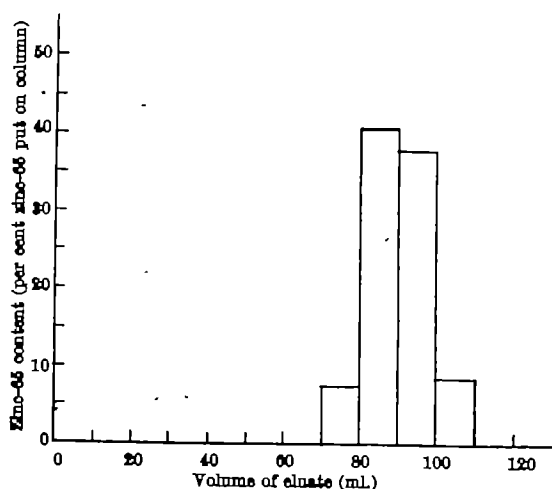


Fig. 1. Chromatographic separation of zinc-65 from irradiated copper (cellulose powder column 10 m. long and 1 in. diameter)

removed by distillation under reduced pressure. The residue is dissolved in a small volume (5-10 ml.) of constant-boiling hydrochloric acid. Copper cannot be detected in this final acid solution by a spot test depending upon the catalytic action of cupric ions on decomposition of the ferric iron-thiosulphate-complex ion¹. This reaction will detect 0.02 µgm. copper at a minimum concentration of 1 part in 2,500,000. The fractions obtained from the surface of the target do not contain sufficiently large amounts of zinc to be detectable by the formation of zinc mercuric thiocyanate in a spot test¹ (sensitivity: 0.2-0.5 µgm. zinc at a minimum concentration of 1 part in 100,000). The fractions obtained from the deeper parts of the target contain small (microgram) amounts of carrier zinc, which may be derived from non-radioactive zinc originally present as an impurity in this part of the target. It has been shown that, under the conditions of these separations, the cellulose powder and reagents do not contribute detectable amounts of zinc to the product.

An example of the recovery of radioactive zinc in serial 10-ml. fractions of the eluate is shown in Fig. 1. The relatively large volume of the solutions chromatographed has necessitated the use of larger columns than those recommended for the chromatographic separation of metals in analytical work². Good results have been obtained with cellulose columns 10 in. long and 1 in. in diameter, and with columns 14 in. long and 1½ in. in diameter.

We are indebted to Prof. A. Wormall for his interest and encouragement, and to the British Empire Cancer Campaign for financial support. The irradiations were performed in the University of Birmingham cyclotron through the courtesy of Profs. P. B. Moon and W. E. Burcham.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Ultra-Violet Irradiation of Tobacco Infected with Potato Virus Y and the Availability of Virus to Aphids

SINCE many workers in widely divergent fields are interested in the biological effects of ionizing radiations, new methods of approach to this study may have wider application than is at first realized. This communication reports that ultra-violet irradiation of tobacco infected with potato virus Y can reduce the availability of virus to aphids without causing apparent injury to the plants or greatly reducing the infectivity of sap extracts as measured by starch-iodine lesions.

Leaves of White Burley (*Nicotiana tabacum* L.) tobacco plants showing well-developed symptoms of infection with potato virus Y were irradiated in the dark 15 cm. from a source of ultra-violet light. (The intensity of radiation of 2537 Å. on the surface of the leaves was about 2 mW. per sq. cm.) Half of each leaf was either removed or covered during irradiation to serve as an unirradiated control. After irradiation, the plants were placed in daylight under glass for several hours, and then kept under normal glasshouse conditions of illumination. The availability of virus to aphids was tested with fasted wingless adults of *Myzus persicae* (Sulz.), which were transferred in pairs from the source of infection to young healthy tobacco plants for 24 hr.

When aphids spent two minutes on the leaves immediately after irradiation, the pairs out of 70 that transmitted from leaves irradiated zero, two, four and eight minutes were 68, 28, 11 and 1 respectively. Many fewer transmissions resulted when the aphids spent four hours on the leaves; but the differences in the numbers of transmissions from irradiated and unirradiated leaves were similar to those above. Irradiation of one surface of a leaf did not affect the availability of virus from the other; nor did irradiation appear to affect the feeding behaviour of the aphids. The irradiated plants continued to grow and looked the same as the controls, and the availability of virus to aphids returned to normal within a few days. For example, after two to four days, as many transmissions were obtained from leaves irradiated two minutes as from the controls, and transmissions from leaves irradiated five minutes equalled that of the controls after five to ten days.

Ultra-violet irradiation of some plant viruses *in vitro* results in a loss of infectivity without any gross changes in their physicochemical properties¹ and, by analogy, virus infectivity is probably destroyed *in vivo* when infected plants are irradiated. Although detailed infectivity tests have not yet been done, the following tests indicate that if ultra-violet destroys infectivity *in vivo*, then only a small part of the total virus in a leaf is so affected during the brief periods of irradiation required nearly completely to reduce the availability of virus to *M. persicae*. Infected leaves were divided along the mid-veins, and one-half of each leaf was irradiated for five minutes, the other half serving as an untreated control. The pairs of aphids out of 20 that transmitted virus after two minutes on these leaves were zero for the irradiated

and 18 for the controls. Sap expressed from each group of half-leaves and diluted with an equal volume of phosphate buffer at pH 7 was inoculated on opposite half-leaves of tobacco. Sap from the irradiated leaves produced as many starch-iodine lesions² as that from the controls in one experiment; when repeated, however, slightly fewer lesions were produced by sap from the irradiated leaves, the difference being less than 10 per cent.

M. persicae becomes infective with potato virus Y during feeding punctures when the stylets are inserted into the epidermis of infected plants, and transmission rarely, if ever, occurs after the stylets have penetrated into deeper tissues³. Therefore, it is only necessary to postulate inactivation of potato virus Y in the epidermis of the irradiated tobacco leaves to account for the results reported here.

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Protein Synthesis and Genetics

THE recent exchange of views in *Nature* regarding the biosynthesis of proteins prompts some comments from a geneticist. Campbell and Work¹ take note of "the two main streams of thought on protein synthesis: one derived from the study of isolated enzyme systems and suggesting a stepwise coupling of many small peptide units; the other based on the study of genetic inheritance of protein specificity and preferring synthesis on templates, each template being specific for a single protein structure and probably identifiable with a gene". While not rejecting the latter view (one gene-one protein), they point to some of the difficulties with which it is confronted, and further suggest the possibility that a synthesis of the two ideas will be found to fit the facts. Dounce², on the other hand, elaborates and defends a nucleic acid template hypothesis, and suggests that such a hypothesis is consistent with the existence of both plasma genes and nuclear genes. Quite independently, immunogenetic and biochemical studies of controllable genetic material have yielded results suggesting a synthesis of these views.

In *Drosophila melanogaster*, genic interaction has been demonstrated in the determination of antigenic specificity, a finding difficult to reconcile with the one gene-one protein hypothesis. In one series of isogenic stocks, interaction between at least three non-allelic loci is responsible for the presence or absence of a particular antigenic component. Two of these loci have been identified (ruby and vermilion), and have morphological as well as antigenic effects³. In another series of isogenic stocks, interaction between alleles results in a distinctive antigenic component in heterozygotes. The interaction involves the wild and mutant alleles at the loci

for lozenge *BS* and/or lozenge-46⁴, which are also notable for their pseudoallelism⁵. In the former case the interaction antigen is undoubtedly protein⁶, and in the latter case it is probably protein. The patterns of interaction in these cases are such as to suggest that protein synthesis occurs in two gene-controlled stages: a series of preliminary steps leading to the production of non-specific precursors, and a second stage during which final specificity is conferred upon the product.

In *Neurospora crassa*, the genetic control of the enzyme tyrosinase in strain 15300 (albino-2) has been subjected to intensive investigation. Only a preliminary report has been published⁷ and the analysis is not yet complete, but available results are suggestive enough to deserve comment. The enzymatic activity of homogenates of cultures grown under standardized conditions has been measured with two substrates, tyrosine and 3,4-dihydroxyphenylalanine. As has been reported, the two mating types of strain 15300 differ in tyrosinase activity, mating type *a* exhibiting high activity and *A* exhibiting no measurable activity. Single ascospore cultures isolated from the crosses 15300*A* × 15300*a* also exhibit differences in tyrosinase activity, ranging from activities as low as that of 15300*A* to activities higher than that of 15300*a*, and varying independently of mating type. The distribution of activities among cultures of the progeny suggests multiple factorial inheritance. Since the differences in activity cannot be attributed to extraneous factors such as inhibition, the simplest interpretation of these results is that the level of enzyme concentration in this strain is controlled by a multiple genic system. Completion of the genetic analysis of this situation has awaited the development of suitable genetic methods⁸, and is now under way.

The specificity of the enzyme, as measured in terms of its relative activity with the two substrates, also varies among the cultures, but independently of level of activity. The inheritance of this difference is again not simple; but the data suggest one locus with a major effect on specificity and several with smaller effects. This situation is also being investigated further.

Tentative as they are, these results nevertheless suggest a duality in the genetic control of tyrosinase synthesis. One genetic system seems to control enzyme concentration, and a second seems to control enzyme specificity. Such duality suggests in turn a two-stage process in enzyme synthesis: a preliminary stage involving the synthesis of non-specific precursor (protyrosinase) under the control of one genetic system, and the conversion of precursor to enzyme (tyrosinase) under the control of a second system. Quantitative aspects of enzyme synthesis could involve the first stage, and specificity could be conferred during the second. This hypothesis has led to the demonstration of protyrosinase in this material. The kinetics of its development and the mechanism of its conversion to active enzyme are being studied.

The similarity of the conclusions drawn from the two aspects of this work, that with *Drosophila* and that with *Neurospora*, is notable. In connexion with the previous discussion in *Nature*, it might be suggested that the synthesis of non-specific precursor occurs in a stepwise fashion, while specificity is the function of template action. If this is the case, the gene-template relationship cannot be simple, as judged from our *Neurospora* data, and perhaps the

template itself is synthesized by a similar two-stage process. The genetic control of protein synthesis would in any event be indirect and complex, perhaps approaching the level of complexity of the genetic control of morphogenesis.

Such an epigenetic point of view leads one to expect environmental-cytoplasmic-nuclear interactions in protein synthesis, and it is therefore interesting to note that the *Neurospora* tyrosinase appears to be adaptive. The genetic analysis is therefore performed with material grown in the presence of substrate (tyrosine); but the observation of enzyme adaptation suggests a cytoplasmic mechanism which is triggered by environmental factors and which interacts with the nucleus, such as has been discussed by other workers⁹.

I wish to acknowledge the contributions made to this work by Mr. V. Feldmiller, Mr. R. O. Wolf, Dr. A. Chovnick and Dr. S. Koritz. The work itself was supported by research grants from the National Institutes of Health and performed at the Ohio State University.

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Culture *in vitro* of Cambial Tissue of Cacao

DURING work on the physiology of rooting cacao cuttings, attempts were made to induce the formation of roots on isolated stem sections in sterile culture. Although no differentiation was obtained, the profuse growth of callus tissue at the morphological base of the section suggested that cacao would be a suitable subject for tissue-culture investigations.

Further experiments showed that isolates of bark similar to bud 'shields' could be cultured successfully on a simple solid medium, such as that used by Gautheret¹ for his initial isolations. These cultures produced sufficient cambial tissue in two to three months for subcultures to be made; growth of the new tissue was visible after 24 hr. No external source of growth substance was found to be necessary for growth.

The nutritional requirements of the sub-cultures, consisting of cambial tissue only, were more complex than those of the original isolates. White's standard formula² supported only very slow growth. Spectacular increases in the growth-rates were obtained, however, with the addition of coconut milk in varying concentrations to White's medium. The highest rate of growth was given on a medium of pure coconut milk. The subcultures were grown on liquid medium by a method similar to that described by Stokes³ for

embryo-culture. Initial isolates did not grow as well using the liquid method of culture as on a solid medium.

No external source of growth substance was employed with those media containing coconut milk. Subcultures grown on White's medium alone showed no response to the addition of low concentrations of growth substance, and higher concentrations, of the order of 10^{-4} , caused considerable losses.

Isolates from plants infected with 'swollen shoot' virus have also been cultured successfully. Eight to ten successive subcultures have been made from isolates from such infected plants. It has not yet been possible to demonstrate the presence of the virus in the isolates or in the newly formed tissues. This may be largely because of the limitations imposed by the available methods of testing for the virus. The nutritional requirements of the 'infected' cultures are similar to those of healthy tissues, and the growth-rates are similar. Histological examination of these tissues has so far shown no differences from healthy tissues.

Referring particularly to the tissue of *Vitis*, Gautheret¹ suggests that the physiology of this tissue is so greatly changed, when cultured upon a medium containing coconut milk, as to bear no relation to that of normal tissue, and that the intense proliferation of the tissue is often of a pathological nature.

The tissue produced upon explants from cacao is normally compact, white and granular. When subcultured upon White's standard medium with pantothenic acid and biotin, the newly formed tissues present a similar appearance. No growth takes place at the point of contact of the culture with the medium, whether the latter be liquid or solid. When subcultured upon a medium containing coconut milk, however, the morphology of the tissue is greatly changed. Further, there is a considerable difference between tissues cultured on solid media and those on liquid.

On agar slopes, the typical white mass of tissue is gradually overgrown by a disorganized, loosely granular tissue, which is pale brown in colour and translucent. The growth is rapid compared with that on the standard medium. The subcultures retain this appearance. When subcultured on liquid coconut milk by Stokes's² method, the change in the morphology of the tissue is even more marked. Proliferation takes place only at those points of the culture in contact with the medium-soaked filter paper. The original tissue is raised from the surface of the paper by one or more masses of new tissue. The latter, while still pale brown and translucent, is compact but extremely soft and 'mushy'. The original culture ultimately dies. Further subculture of the new tissue is made easy by the fact that all the cells composing it seem capable of division; it is so soft that a smear of the tissue across the surface of the filter paper support will, in the course of a month, give rise to masses of tissue large enough for further subculture.

After about four subcultures on coconut milk, in some cases a further change in the morphology of the cultures is noticeable. The tissue becomes practically colourless, and of a much more granular and solid nature. This form is maintained in succeeding subcultures. The differences in morphology of those cultures grown on agar slopes containing coconut milk, compared with those grown on a liquid medium, are probably due to the greater avail-

ability of nutrients, growth substances and the so-called 'coconut milk factor' in the latter.

I wish to thank the Director of Cacao Research, West African Cacao Research Institute, for permission to publish this communication. A full report of the work will be given later.

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Occurrence of Endosperm Haustoria in some Cucurbitaceae

THE embryology and seed structure of the Cucurbitaceae have attracted much attention, and a good deal of work has been done by Longo, Kirkwood, Kratzer, Singh, and others¹, most of it based on a study of sections. However, sections often fail to give a three-dimensional picture of an organ, and occasionally even simple structures are ignored or overlooked. In my work I used both sections and dissections, and observed characteristic endosperm haustoria in several members of this family, which have not been reported earlier.

Species of the following genera were investigated: *Trichosanthes*, *Lagenaria*, *Luffa*, *Momordica*, *Cucumis*, *Citrullus*, *Coccinia*, *Ocucurbita*, *Melothria*, *Blastaria* and *Actinostemma*. All these except *Blastaria* were found to possess a chalazal endosperm oecum. A comparative account of the endosperm of *Momordica*, *Trichosanthes*, *Luffa* and *Lagenaria* is presented below.

The endosperm is of the nuclear type. Soon after fertilization, the embryo-sac elongates (Fig. 1) and its upper part broadens while the lower remains narrow. Wall formation occurs only in the former. It is simultaneous in *Lagenaria*, *Luffa* and *Trichosanthes*, whereas in *Momordica* it progresses from the apex downwards (Figs. 2, 3, 4). The chalazal end, which is oocytic, forms a tubular process (Figs. 4, 10) which soon becomes worm-like in *Trichosanthes* (Fig. 6) and assumes a shape similar to that of the 'vermiform appendage' of some members of the Proteaceae². Frequently, the nuclei present in the chalazal process are larger than those in the upper cellular part (Figs. 4, 11).

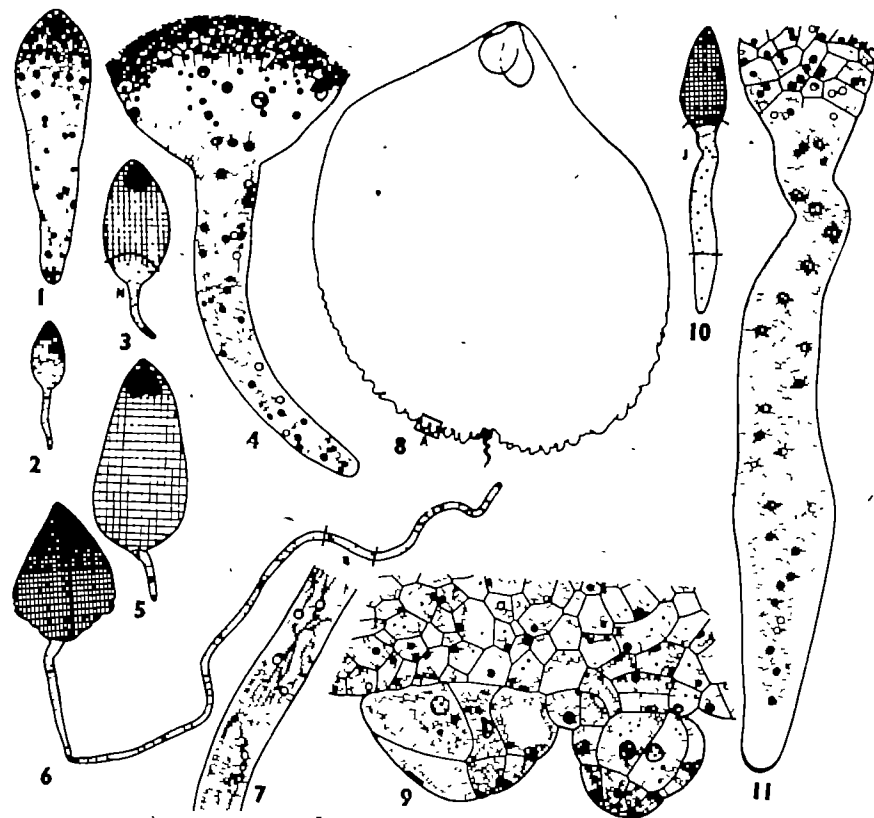
The maximum length attained by the appendage varies from 700 μ in *Momordica* to more than 6,000 μ in *Trichosanthes*. The haustorium shows dense granular cytoplasm with many free nuclei (Figs. 4, 7, 11) which often aggregate in groups of 3-7. The nucellar cells around the appendage present a furnished appearance and gradually their walls break down.

The cellular part of the endosperm increases greatly in size by cell divisions and cell enlargement. The nuclei of the centrally situated cells become markedly hypertrophied and irregular in outline. In the basal portion the outer cells bulge out prominently, this feature being specially pronounced in *Luffa* (Figs. 8, 9).

Due to the enormous increase in size of the cellular part of the endosperm and the aggressiveness of the haustorium, the surrounding nucellar tissue is gradually used up.

The chalazal haustorium remains oocystic in *Trichosanthes*, *Luffa* and *Lagenaria*. Only in *Momordica* does it sometimes become cellular. It is at the peak of its activity at the heart-shaped stage of the pro-embryo, after which its contents begin to degenerate and disappear and the wall shrinks, and it comes to lie close to the base of the cellular endosperm (Fig. 8).

In advanced stages the endosperm is consumed by the developing embryo, and at maturity the cotyledons occupy the whole of the seed cavity.



Figs. 1-4. Development of endosperm in *Momordica charantia*; for explanation, see text. Fig. 4 is enlargement of the part marked N in Fig. 3. Magnification: Figs. 1 and 4, $\times 75$; Figs. 2, 3 and 5, $\times 10$.
Figs. 6 and 7. Endosperm of *Trichosanthes angurina*; Fig. 7 is enlargement of the part marked B in Fig. 6. Magnification: Fig. 6, $\times 24$; Fig. 7, $\times 110$.
Figs. 8 and 9. Endosperm of *Luffa acryptica*; Fig. 9 is enlargement of the part marked A in Fig. 8. Magnification: Fig. 8, $\times 11$; Fig. 9, $\times 112$.
Figs. 10 and 11. Endosperm of *Lagenaria vulgaris*; Fig. 11 is enlargement of the part marked J in Fig. 10. Magnification: Fig. 10, $\times 9$; Fig. 11, $\times 112$.

None of the families believed to be allied to the Cucurbitaceae is known to possess a similar endosperm oecum, but it would be interesting to reinvestigate them using whole mounts as well as sections.

I thank Prof. P. Maheshwari and Dr. B. M. Johri for their encouragement and valuable suggestions during the course of this study.

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¹ Longo, B., *Ann. N. Bot.*, 1, 71 (1903). Kirkwood, J. B., *Bull. N.Y. Bot. Gard.*, 2, 313 (1906). Kratzer, J., *Flora*, 10, 275 (1918). Singh, Bahadur, *Phytomorphology*, 2, 224 (1953).
² Kausik, S. B., *Proc. Ind. Acad. Sci.*, B, 16, 121 (1942).

Plasmodium berghel in the Placenta of Mice and Rats: Transmission of Specific Immunity from Mother Rats to Litters

THE problem of transplacental transmission of *Plasmodium berghel* from mother mice and rats to their litter was investigated by infecting gravid animals during the week preceding parturition. 22 white mice and 12 albino rats were inoculated intravenously with a standard dose of 10^4 parasites per 100 gm. weight of the animal. All mice died

within an average of 12.4 days after the infection. Ten rats survived the infection and developed a consequent immunity. 15 mother mice lived long enough to deliver; two of which produced stillborn litters while 13 delivered normally. All live-born baby mice were free from infection at the time of birth, and when nursed by foster mothers remained healthy and developed normally for more than two months. The stillborn mice showed no parasites on direct smears, and sub-inoculations from them were negative; but they had an accumulation of pigment in the liver. This pigment (giving a negative histochemical test for iron) might have been produced as a result of a fatal intra-uterine infection.

Ten gravid rats infected with *P. berghel* showed a typical course of infection followed by recovery. They produced a total of 76 non-infected baby rats, all of which, nursed by their own mothers, developed normally for more than three months. Sections of placentae of three mother rats showed a heavy concentration of pigmented parasites in decidual sinuses and in the meshes of the placental

labyrinth; but the foetal villi were free from parasites. Neither the syncytial trophoblastic tissue nor the cellular elements of the placental labyrinth showed any marked reaction to parasites accumulated in the lacunae in very great numbers. The phagocytic activity of the 'giant cells' was not unduly marked, though some of them contained grains of pigment.

It seems that the penetration of parasites through the haemoendothelial barrier of the placenta of mice and rats is an exceptional occurrence, due perhaps to a mechanical or most probably functional deficiency, and followed as a rule by an early death of the foetus.

The transmission of specific immunity from mothers to their litter was investigated in rats. Ten adult females were given, after their recovery from

the first infection, three to four weekly intraperitoneal inoculations of *P. berghoi*, beginning with 20 million and ending with 60 million parasites. The rats were mated, and during the second half of their pregnancy received one or two intravenous inoculations of 25 million parasites.

All these rats produced normal litters which were nursed by their own mothers. Each litter was divided into three groups, and the combined litters in each group were challenged by an intraperitoneal inoculation of 1-3 million parasites at 2 weeks, 3 weeks and 4-5 weeks of age. The baby rats were followed up by blood examinations every two days (Table 1).

Table 1. RESULTS OF CHALLENGING INFECTIONS WITH *P. berghoi* OF LITTERS PRODUCED BY IMMUNE AND NORMAL MOTHER RATS

	Litter from immune mothers			Litter from normal mothers		
	Age at challenge (days)			Age at challenge (days)		
	13-15	20-22	23-25	13-15	21-23	23-24
Numbers challenged	22	20	18	18	19	20
Dose of parasites	10 ¹	2 × 10 ¹	3 × 10 ¹	10 ¹	2 × 10 ¹	3 × 10 ¹
Numbers died	22	17	9	18	19	19
Mortality (per cent)	100	85	50	100	100	94.5
Average survival time of fatal infections (days)	12.5	15	18.6	10.8	14.6	14.8
Mean peak parasitaemia (per cent parasitized red blood cells)	94.0	80.5	67.4	94.4	98.5	91.0

It appears that young rats born from mothers immune to *P. berghoi* exhibit some tolerance to a challenging infection with this parasite, whereas the infection in control baby rats delivered from normal mothers is usually fatal. This transmitted tolerance becomes obvious only towards the end of the nursing period.

To find whether the young rats obtain their inherited relative immunity through milk, four groups of litters produced by two immune and two normal mother rats were interchanged at the age of 3-4 days after birth and later challenged at the age of 15 and 30 days respectively (Table 2).

Table 2. RESULTS OF CHALLENGING INFECTIONS WITH *P. berghoi* IN TWO GROUPS OF INTERCHANGED LITTERS

	Litter from immune mother nursed by a normal mother		Litter from a normal mother nursed by an immune mother	
	Age at challenge (days)		Age at challenge (days)	
	15-16	30-32	14-16	31-32
Numbers challenged	6	7	7	8
Numbers died	6	6	6	5
Mortality (per cent)	100	85	85	62.5
Average survival time of fatal infections (days)	14.5	16	12.2	13.5
Mean peak parasitaemia	91.0	94.6	93.7	76.0

The results of this preliminary investigation suggest that any inherited relative immunity to challenging infections with *P. berghoi* in young rats is transmitted mainly by milk of immune mothers and evident only during the late part of the nursing period.

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Spawning Sites of Trout

In a previous communication¹, it was stated that field observations suggest there is a regular downward flow of water through the gravel beneath the river-bed at the sites favoured by salmon and trout when making the spawning redd. The course of these sub-surface currents, as experimentally determined in the laboratory in a 6 ft. × 1 ft. artificial stream pool, was described. It was found that the maximum flow occurs in the vicinity of the mound of gravel usually present near the lower end of a spawning pool, that is, where redds are commonly found. The present spawning season offered an opportunity of testing the behaviour of a pair of gravid trout introduced into the experimental pool. Normal 'courtship' behaviour was observed and spawning took place. Ova (425) were deposited in three pockets, all excavated within the predicted area, the site of the initial cutting being just below the apex of the gravel mound, where the strongest sub-surface flow had been found to occur; 100 per cent fertilization resulted. In a second experiment with another gravid pair, three pockets of ova have been again deposited in exactly the same site.

An interesting demonstration of the penetration of stream water into the sub-surface gravel was obtained by burying ripe ova, obtained by stripping a female trout, in the mound of gravel in the experimental tank, some 4 ft. distant from the inflow. A dilute suspension of spermatozoa from a ripe male was then poured into the inflow rush. Investigation showed 30 per cent of the buried ova to have been fertilized by spermatozoa carried by downward currents through the gravel. A second similar experiment with a more concentrated suspension of spermatozoa yielded just over 60 per cent fertilization. These results suggest that in a stream with a mixed salmonid population cross-fertilization is at least possible on physical grounds.

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¹ Stuart, T. A., *Nature*, 172, 407 (1953).

A New Species of Freshwater Triclad belonging to the Genus *Polycelis*

OUR studies of the genus *Polycelis* from western Europe have revealed that the species complex *nigra-tensis* in reality includes not two but three different species, which are easily recognized if the anatomy of the copulatory organs or the chromosomes are studied. However, it is scarcely possible to identify these species from their external appearance.

Below, the main species differences are set down, though the anatomy (E. H.-M.) and the chromosomal conditions (Y. M.) will be described soon, in full, elsewhere.

Polycelis nigra (O. F. Müller, 1773) has a short, rounded penis with two to three rows of chitinous spines around its opening. The glandular bursa is large. There are no adenodactyls.

Polycelis tenuis Ijima, 1784 has a large, long and pointed penis, the surface of which is covered with thick chitinous spines. The glandular bursa is a small one. This species always has two well-developed adenodactyls.

Polycelis hepta n.sp. will be the name of the new species formerly confused with the other two. It has a large pointed penis like that of *tenuis*. The distal third of the surface of the penis is covered with small epithelial light-refracting bodies. The glandular bursa is similar to that of *tenuis*. There are never any adenodactyls in *hepta*.

The haploid chromosome number is 8 in *nigra*, 8 in *tenuis* and 7 in *hepta*. The name of the latter species refers to the chromosome number. *Nigra* is commonly diploid, whereas *tenuis* has established a bisexually reproducing tetraploid form in England. Out of the diploid *hepta* have arisen triploids and tetraploids with $3 \times 7 = 21$, and $4 \times 7 = 28$ chromosomes respectively. These latter forms are able to propagate either by obligate or facultative parthenogenesis. The polyploid parthenogenetic forms are very successful, having a distribution over most parts of western Europe, whereas the bisexually reproducing diploid type, according to our knowledge, is restricted to a few localities in the mountains of western Europe.

Some observations have been made on the ecology of *P. hepta* during a survey of the triads of lakes (T.B.R.). Other kinds of freshwater habitats are not dealt with here.

The most oligotrophic British lakes do not support a *Polycelis* fauna. *Nigra* is the first species to appear in the less oligotrophic lakes. In lakes of increasing eutrophy it is gradually replaced by the tetraploid *tenuis*, which becomes numerically dominant. *Polycelis hepta* occupies a position of relative maximum abundance in lakes between the two extremes, but extending into the eutrophic habitat. It is therefore found with both *nigra* and *tenuis* but more usually with the latter, and mixed populations of *tenuis* and *hepta* are the rule. However, in certain lakes not rich enough to support *tenuis*, *hepta* may occur with *nigra*, less commonly alone. In Sweden, *Polycelis hepta* is similarly related to *tenuis* ecologically; but some differences may be attributed to the fact that the latter species is diploid in Sweden and not tetraploid as in the British lakes. Another contrast between the two areas which has ecological consequences is the lack of competition from *Polycelis nigra*, which does not occur in Swedish lakes.

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Breeding of Mice at -3°C .

THE house mouse, *Mus musculus* L., can live and breed¹ in cold stores kept permanently well below 0°C . We have found that laboratory strains of this species, provided with cotton wool for nesting, can be bred in cages in a room kept at -2° to -4°C .

Two families of white mice, of the Strong A strain, have, in nine and ten months respectively, reached the third generation born and reared in the cold. Control families, derived from litter mates of the experimental mice, were kept at 10° and 20°C . respectively: these reached the fourth generation in the same time. One family of inbred O67 (black) mice has, in eight months, reached the second

generation in the cold; in the same time, a control family reached the third generation at 20°C . We find no reason for doubting that these two strains could be bred indefinitely at -3°C .

The fertility of mice reared at 20°C , and transferred to -3°C . before mating, has been compared with that of litter-mate controls kept at 20°C . Ten pairs of the Strong A strain were mated at each temperature, and bred for periods of 18-27 weeks, with the following results:

	-3°C .	20°C .
No. of litters born	42	48
No. of litters weaned	37	44
Total young weaned	176	231
Mean number young weaned per weaned litter	4.73 S.D. -1.66	5.25 S.D. -1.66
Mean weight in gm. at weaning	8.70 S.D. -1.61 9.02 S.D. -2.11	10.10 S.D. -1.76 10.46 S.D. -1.66

Temperatures in the nests, of pairs with litters aged 1-7 days, were recorded by means of a thermocouple put on or among the nestlings. In the cold room the nest temperatures varied from 20.2° to 32°C . in twenty readings; eleven of the readings were higher than 26°C . Pairs with older, more active litters, or without litters, did not maintain nests at such high temperatures. In the room kept at 20°C . the temperatures of nests with young litters varied from 27.8° to 30.8°C . in eight readings. Nests in the cold were better constructed than those in the warm.

The general conclusion is that, in the conditions of this experiment, laboratory mice are able to make a physiological adaptation to temperatures below freezing point, without major loss of fertility. The functional changes involved in this process are being studied.

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¹ Laurie, H. M. O., Proc. Roy. Soc., B, 123, 248 (1946).

Occurrence of the Lancelet in Haifa Bay, Israel

A SPECIMEN of *Branchiostoma lanceolatum* (Pallas) was collected during the September 1953 cruise of the research vessel of the Sea Fisheries Research Station at a position at $32^{\circ} 53' 36''\text{N}$, $35^{\circ} 1'\text{E}$, in Haifa Bay at the depth of 15 fathoms. Another station in the eastern Mediterranean has thus been added to the zoogeographical distribution of the lancelet. It was not unexpected that the animal should occur somewhere along the Israel Mediterranean coast, in view of the geographical proximity of the other stations where the species has been previously recorded. The lancelet, however, was not found during the previous bottom investigations carried out along the Israel coast during the years 1946-52 at the 10-, 30-, 50- and 75-fathom lines, of which only the 10-fathom line lies on sandy bottom. In these investigations a Pettersson bottom-grab and a dredge were used.

At the station where the specimen was collected, the bottom is composed of gravel in which mollusc shells, bryozoan skeletons and corals are found, and it is in the vicinity of a sandy area interposed by rocks.

Of the thirteen species of the genus *Branchiostoma*, *B. lanceolatum* is the only one to be found in the Mediterranean. Steuer² collected specimens of the lancelet in the vicinity of Alexandria (September–November 1933); their maximal size was 32 mm. and they conformed with *forma typica*. He further mentions that those collected off Rovigno d'Istria (September 1935) were of 43.5 mm. maximal size, and states that a different specific form of this species occurs in the Black Sea.

The specimen collected in Haifa Bay measures 36 mm., weighs 0.127 gm., has 59 myotomes and seems to conform with the typical form of the species *Branchiostoma lanceolatum* (Pallas).

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¹ Bigelow, H. B., and Fanfante, I. P., "Lancelets, Fishes of Western North Atlantic" (Bears Foundation for Marine Research, Yale University, New Haven, 1948).

² Steuer, A., Notes and Memoirs No. 30, Fisheries Research Directorate Egypt (1939).

ABO Groups in Blood Platelets

It has been found that suspensions of blood platelets in normal saline are agglutinated by A-, B- and O-sera, just as these sera agglutinate red blood cells of the corresponding blood group. It is thus possible to establish four blood groups for the blood platelets, similar to the blood groups in erythrocytes.

The following technique was used in the study. All glassware was coated with silicone to render it non-wettable. Disodium sequestrene was used as an anticoagulant. Triton W.R. 1339¹ 2 per cent¹ was added to reduce irreversible clumping of the thrombocytes. Blood freshly drawn into siliconized tubes was centrifuged in cups filled with ice, at 800 r.p.m. for ten minutes. The plasma was pipetted off and centrifuged again for five minutes at 800 r.p.m. in order to remove the remaining red and white blood cells.

Plasma containing a pure suspension of thrombocytes was now centrifuged five minutes at 2,000 r.p.m. to obtain a sediment of concentrated blood platelets. The plasma was then siphoned off, and it was found that the sediment contained a concentration of 3–5 million platelets per cubic millimetre. This sediment was washed three times with normal saline and then suspended in normal saline at a dilution of 1:10, in order to obtain a count of about 500,000 per c.mm.

The typing of the blood platelet suspension was performed as follows. To 0.3–0.5 c.c. of inactivated serum in a tube an equal volume of the platelet suspension was added and left at room temperature for two hours. The result of agglutination was read microscopically after two hours, by withdrawing several drops of the serum-platelet suspension and spreading it on a slide. Agglutinates of different sizes, from several to tens of thrombocytes, and large clumps of platelets were clearly visible at low magnification. At the first reading after two hours, about 30 per cent of the platelets remained unagglutinated. When left at room temperature for eight hours, large clumps of agglutinated thrombocytes were seen macroscopically. Control examinations of platelets

suspended in their own serum or in inactivated serum of the same group always remained negative. No signs of agglutination in the control tests were observed after 24 hr. Similar results were obtained at both 37° C. and at room temperature.

Examinations of platelets from forty different bloods have been carried out, and all have corresponded to the erythrocyte grouping.

When fresh non-inactivated sera were used, or when fresh complement was added to the inactivated serum, a mesh was formed which contained the thrombocytes.

Platelets from blood of group	A serum	B serum	O serum	AB serum	0.9 per cent sodium chloride
O	—	—	—	—	—
A	—	+	+	—	—
B	+	—	+	—	—
AB	+	+	+	—	—

+, Agglutination; —, non-agglutination.

The accompanying table illustrates agglutination of blood platelets by A-, B-, O- and AB-sera.

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Hypoglycin A,B: Biologically Active Polypeptides from *Blighia sapida*

THERE is evidence in literature dating from 1887¹⁻³ that the fruit of *Blighia sapida* (known in Jamaica as *ackee* and in Nigeria as *irin*), a very common article of diet in Jamaica, may contain toxic components. Also, it has been suggested that these components are a contributing cause of Jamaican 'vomiting sickness', an important local disease of, as yet, undefined etiology⁴⁻⁶. However, this view has not been generally accepted^{7,8}. We have attempted the isolation and study of the toxic constituents of the fruit in order to examine the hypothesis.

We have found that the seed of the fruit contains two toxic polypeptides which we have named hypoglycin A and hypoglycin B. The ripe arillus, which is the common article of diet, contains a small concentration of hypoglycin A only. The unripe arillus contains a higher concentration of this compound.

The isolation of the active constituents was controlled by toxicity tests using kittens, rats and guinea pigs. At the outset these tests confirmed earlier observations that the toxicity was extracted by water^{3,4,6}. The active components were separated from water-soluble plant pigments, acids, sugars and starch by absorption on a sulphonated ion-exchange resin. The crude material obtained on elution contained the toxic constituents mixed with some fifteen amino-acids. This mixture was separated quantitatively on ion exchange columns, the procedure being controlled by paper chromatography in addition to toxicity tests. The final purification of hypoglycin A and B was achieved by chromatography on powdered cellulose columns and recrystallization.

Hypoglycin A (melting point 280–284°; $[\alpha]_D^{20}$, +6.75° ± 4° (water): C, 59.40; H, 8.12; N, 11.2

per cent) is a neutral compound which crystallizes readily from methanol-water. It gives a blue ninhydrin reaction and is hydrolysed by hydrochloric acid to a mixture of amino-acids. Paper chromatography using butanol-acetic acid-water (8:1:8) and phenol-water (25 per cent)-ammonia (0.5 per cent) gives single spots with R_F values 0.60 and 0.83 respectively. The infra-red absorption spectrum is in agreement with its formulation as a polypeptide.

Hypoglycin B (double melting point, 194-195°; 200-208°; $[\alpha]_D^{25} + 9.65 \pm 2^\circ$ (water); C, 52.87; H, 6.88; N, 10.55 per cent) is an acidic compound which crystallizes from water-acetone. It gives a blue ninhydrin reaction and is hydrolysed by hydrochloric acid. Paper chromatography using butanol-acetic acid-water (8:1:8) and phenol-water (25 per cent)-ammonia (0.5 per cent) gives spots of R_F value 0.61 and 0.60 respectively.

Both compounds were lethal to kittens, guinea pigs and rats. An estimation of LD₅₀ using twenty-four adult albino rats (body-weight 150-225 gm.) at four dose-levels gave a value of approximately 90 mgm./kgm. for hypoglycin A, but the toxicity was more than doubled when fasted animals were used. Hypoglycin B was approximately half as toxic as hypoglycin A. Hypoglycaemic activity was the most striking pharmacological property observed. Blood glucose invariably fell to less than 20 mgm. per cent before death. There was no significant change in the levels of plasma cholesterol or chloride ion, although the concentration of plasma urea increased to approximately twice normal before death. Histological evidence indicated a marked reduction in the concentration of liver glycogen.

Recently, a study on nine cases of Jamaican vomiting sickness demonstrated that in all instances there was severe hypoglycaemia (3-22 mgm. per cent blood sugar). It was considered that the clinical evidence indicated that the condition was induced by ingested toxic substances*. These observations, and the fact that natural products giving rise to marked hypoglycaemia and low liver glycogen are of limited occurrence, provide further circumstantial evidence of a connexion between the fruit of *Blighia sapida* and vomiting sickness.

Details of this work and further chemical investigations on hypoglycin A and B will be published elsewhere. We are indebted to Mr. Bryan Lutz-Wallace for technical assistance and gratefully acknowledge a grant from the Government of Jamaica.

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Genic Equilibrium of Microcythemia in some Italian Districts

MICROCYTHAEMIA, or thalassaemia minor, is an inherited trait due to an autosomal gene (M), with incomplete dominance, which in the homozygous condition is lethal because all MM die in childhood from a severe anaemia (Cooley's disease or thalassaemia major). Silvestroni *et al.*¹ showed that its frequency ranges, in Italy, from 0.47 per cent (Florence) up to 10.4 per cent (average of several villages in the district of Ferrara), with a rather irregular distribution through the Italian peninsula and islands. They pointed out that the high percentage of microcythemia (Mm) in some populations raises the problem of how such a high percentage of heterozygotes can be preserved through many generations although the gene M is continually eliminated because all homozygotes (MM) die in early childhood.

From the data collected at that time it appeared that the phenomenon could be explained mainly by the fact that $Mm \times Mm$ matings seemed to be more fertile than the others (see Table 2, ref. 1). Haldane (personal communication) has shown that this increase in fertility is insufficient to maintain equilibrium: if the frequencies of Mm and mm are in the ratio $X_n : (1 - X_n)$ in the n^{th} generation, and $Mm \times Mm$ matings produce f times as many children as other types, then, in the next generation:

$$X_{n+1} = (X_n - X_n^2 + \frac{1}{2}fX_n^2)/(1 - X_n^2 + \frac{1}{2}fX_n^2).$$

For equilibrium, $X_{n+1} = X_n = (4 - 2f)/(4 - 3f)$: since $0 < X < 1$, $f > 0$; this implies that $f > 2$, which was not the case in the above data.

Further and more extensive data collected in the summer of 1951 by Silvestroni *et al.*² showed that the percentage of Mm was even higher in some localities near the region of the Po delta (nearly 20 per cent), but in the larger sample thus available, $Mm \times Mm$ matings no longer showed increased fertility (Table 1; the families used in this case were those in which the mother was more than forty years of age, to ensure that all families were complete). Thus, the hypothesis of a differential fertility in favour of one particular type of mating is no longer tenable.

Table 1. DATA COLLECTED IN 1951 (see ref. 3)

Type of mating	Number of families	Average number of children per family	S.E.
$mm \times mm$	1,286	4.89	0.183
$Mm \times mm$	793	5.03	0.217
$Mm \times Mm$	79	4.99	0.749

Another possible explanation is increased fitness of the genotype Mm . In this case it is easy to demonstrate that even a very small advantage could be enough to keep the genic system in equilibrium⁴.

Penrose⁵ showed that, when there is equilibrium, fitnesses may be expressed in terms of gene frequencies. Denoting by q and p the respective frequencies of the normal gene m and the mutant gene M , we have $f = 1 - kp^2$, $g = 1 + kqp$, $h = 1 - kq^2$, as the fitnesses of mm , Mm , MM , respectively, where k is a constant.

Since we know that the fitness of MM is zero (because these individuals die before the age of reproduction), we obtain from the last relation the actual value of k as 1.108, and therefore the theoretical values of f and g for equilibrium are:

$$f = 1 - kp^2 = 0.997 \\ g = 1 + kqp = 1.053.$$

This means that a difference of the order of 0.05 could be enough to balance the loss of the gene *M*.

In practice, it is difficult to measure 'fitness'. A direct measure is given by the ratio of the proportion of a genotype among parents to that among offspring (Penrose⁴). In this way, we obtained a rough estimate of the actual values of fitnesses in our populations (Table 2).

Table 2

Genotype	Frequency among 5,904 parents (a) (per cent)	Frequency among 10,355 offspring (b) (per cent)	Direct estimate of fitness (a/b)	Theoretical value for equilibrium
<i>mm</i>	89.9	89.5	1.004	0.997
<i>Mm</i>	10.1	9.8	1.031	1.053
<i>MM</i>	0.0	0.7	0.000	0.000

From this table it may be seen that, although it is not possible to demonstrate the significance of the difference in the fitness values between the two genotypes *Mm* and *mm*, this difference is in the right direction and of the right order of magnitude.

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Formation of Nitrite from Oximes and Hydroxylamine by Micro-organisms

It has recently been shown¹ that a number of micro-organisms can form nitrite from various oximes, although the mechanisms involved have not yet been elucidated. We have now established that some organisms capable of forming nitrite from oximes (for example, *Alcaligenes*, *Corynebacterium equi*, and strains of *Nocardia coralina*) can also form nitrite from hydroxylamine if the hydroxylamine is added in sufficiently low concentrations to washed suspensions of the cells. Typical results are shown in Table 1. Nitrite formation from both hydroxylamine and pyruvic oxime was inhibited by hydrazine over the range *M*/100–*M*/1,000 hydrazine, but not by *M*/1,000 thiourea or allylthiourea.

These results suggest that both hydroxylamine and pyruvic oxime may be converted to nitrite in these organisms by a similar path. They also suggest that this path may resemble that involved in the formation of nitrite from hydroxylamine in *Nitrosomonas*, where a mechanism of formation sensitive to hydrazine but insensitive to thiourea or allylthiourea is also known to occur². Further details about this mechanism are not, however, available, simply because

Table 1. THE FORMATION OF NITRITE BY WASHED SUSPENSIONS OF *Nocardia coralina* (STRAIN K 6). Cells washed with, and suspended in, *M*/30 phosphate buffer, pH 6.5. Final volume, including all additions, 5 ml. Incubated for 2 hours at 25° with constant shaking. Cell density, 10 mgm. per ml. (approx.)

Hydroxylamine or pyruvic oxime initially present (μmol.)	Nitrite (μmol.) formed during incubation from	
	Hydroxylamine	Pyruvic oxime
6	0.45	2.1
3	0.60	1.7
1.5	0.36	0.41
0.75	0.15	0.18
0	0	0
3*	0	0

* Boiled cell suspension.

Nitrosomonas is so difficult to culture in adequate quantity.

Heterotrophic oxime-oxidizing organisms are, on the contrary, very easily cultured. We therefore intend to study the mechanisms whereby these organisms oxidize hydroxylamine to nitrite. We hope these studies will shed some light on the mechanism of the same process as carried out by the autotrophic *Nitrosomonas*.

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Electrophoretic Behaviour of Hyaluronidase

WHILE the role of hyaluronidase seems to be understood from the biological point of view, there is little information about the constitution and chemical properties of this enzyme; this is due, indeed, to the great difficulty in preparing and purifying the enzymic fraction from the 'mucopolysaccharase complex'. Even in the Hahn¹ procedure, which gives highly active preparations, the so-called purified material is not at all homogeneous as judged by its behaviour in the electrophoresis apparatus and in the ultracentrifuge.

The present communication describes preliminary results of the fractionation of hyaluronidase preparations by filter-paper electrophoresis, in view of the special advantages of filter-paper electrophoresis for studying the enzymic properties of some proteins.

The technique was essentially that of Durrum², using bromophenol blue as stain. The hyaluronidase used for this investigation was prepared from bull testicles by the method of Favilli and Bergamini³; in some experiments, Vister hyaluronidase ('Jalovis', for which I am indebted to Prof. Soldi, of the Vister Laboratories) was employed. In the electrophoretic pattern of the hyaluronidase preparations, four distinct components with different mobilities were observed; in order to determine which of the four components was enzymically active, the portion of the paper strip containing each component was cut out after a run, eluted by the same buffer, and tested for hyaluronidase activity by the turbidimetric technique⁴. Before eluting from the paper strip, a thin

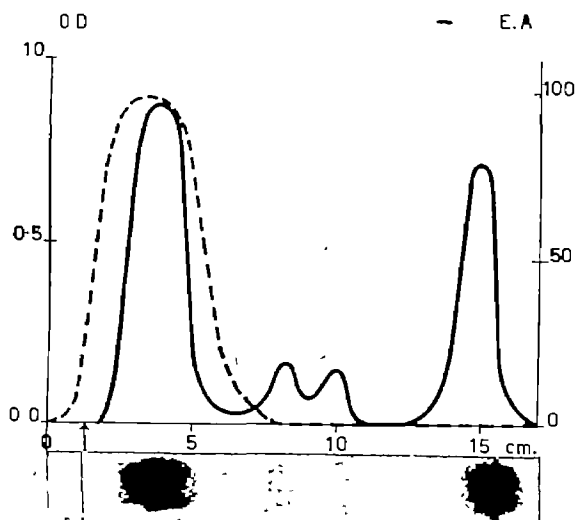


Fig. 1. Quantitative data for paper electrophoresis of hyaluronidase. Vertical axis: continuous line represents values of optical density (O.D.) at 585 mμ; dotted line enzymic activity (E.A.) calculated by relative turbidity reduction. Vertical buffer, pH 8.0; 0.05 M



Fig. 2. Electrophoretic pattern of hyaluronidase. Miller and Golder phosphate buffer pH 7.0, 0.1 M. Left, descending limb after 3,540 sec.; right, ascending limb after 3,420 sec.

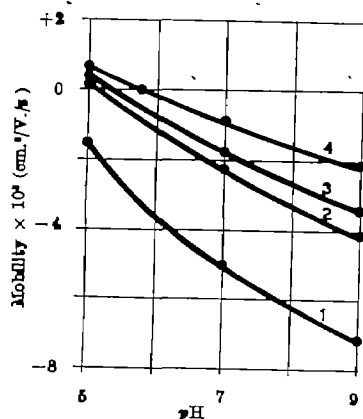


Fig. 3. pH-mobility curves: 4 is enzymically the active fraction

strip on the side was stained to determine the exact position of each component. All the hyaluronidase activity was found to be in the slowest component (Fig. 1). At pH 8.0, therefore, excellent separation of the enzymically active component from the other fast-moving fractions was obtained, which suggests that this technique can be usefully employed in the purification of hyaluronidase. It is also of interest that the mobility of the fastest component was actually greater than that of the albumin.

In order that the real mobility of each component and the isoelectric point of the enzymically active component might be calculated, some experiments were carried out with the classical Tiselius electrophoresis method, using the Perkin-Elmer apparatus. As shown in Fig. 2, the diagrams are almost the same as that obtained with paper electrophoresis; there are, however, slight differences in the mobilities of the intermediate components. From the calculations based on the pH-mobility curve (Fig. 3) the isoelectric point of the enzymic component falls at pH 5.75. This is in agreement with the value found by Hahn.

It seems, in the light of these observations, that the paper-electrophoresis method is, at present, the best procedure for separating the enzymic fraction from the impurities of hyaluronidase preparations.

A fuller discussion of these results will appear elsewhere.

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Non-participation of Folic Acid in the Biosynthesis of Methyl Compounds from Precursors

THE observed impairment in normal creatine and nicotinamide metabolism in folic-acid deficiency, and its partial restoration by administered methanol or formate¹, suggest that a function of folic acid is to check the drain of methyl compounds to formate. The possibility that folic acid may also catalyse the synthesis of methyl compounds from precursors has now been examined.

Adult mice (inbred Swiss strain) were rendered deficient in folic acid as before and divided into groups of four (see table), receiving as supplements folic acid (10 γ/mouse/day, orally) and/or methanol (1 mgm./mouse/day, intraperitoneally) with corresponding controls. On the eighth night from the commencement of this grouping, feed cups were withdrawn from all the cages; on the following morning animals of groups 2 and 4 were each given intraperitoneally 0.6 c.c. of a solution containing 1 mgm. of methanol and 2 mgm. of *DL*-serine; stoichiometrically, these additions represented an approximate molecular ratio of 3:2, since one mole of *L*-serine gives rise to one of ethanolamine through decarboxylation, *D*-serine being inactive in this respect². It should be stated that even though

Group	Choline (mgm./gm. of liver)	Methionine (mgm./gm. of liver)	Phospho- creatine (mgm./gm. of muscle)
1. Basal (no folic acid)	5.17 ± 0.07*	4.80 ± 0.56*	0.337 ± 0.026*
2. Basal + methanol + serine	5.50 ± 0.10	5.23 ± 0.14	0.355 ± 0.034
3. Basal + folic acid	6.07 ± 0.02	5.04 ± 0.09	0.457 ± 0.043
4. Basal + folic acid + methanol + serine	6.35 ± 0.48	5.76 ± 0.83	0.415 ± nil

* Standard error.

serine could be derived *in vivo* from methanol, it was administered simultaneously here to eliminate the known effect of folic acid at this step. Animals in groups 1 and 3 were given mock injections with similar quantities of distilled water. All animals were allowed access to food one hour after injection. They were sacrificed five hours later; liver, viscera and samples of skeletal muscle were quickly removed and stored in a deep freeze ($-5^{\circ}\text{C}.$) for determinations of choline³ and methionine⁴ in the former and of phosphocreatine⁵ in the latter.

The observed increase in the values for choline, methionine and phosphocreatine in group 3 over those in group 1 may be due to a greater conservation of labile methyl due to the check on its breakdown to formate³ as well as to possible increased biogenesis from metabolically derived precursors. However, if the latter were the case, it was to be expected that exogenously supplied precursors should be better utilized for methyl synthesis in presence of folic acid (group 4) than in its absence (group 2). This is not substantiated by a comparison of the data for these groups with the corresponding figures for the control groups.

Density of Visual Pigment in the Frog Retina

A METHOD for preparing suspensions of the frog visual end-organs which were suitable for spectrophotometric analysis¹ has been used to redetermine the density of visual purple in the frog's retina.

Retinae were removed from the eyes of dark-adapted frogs, using a method described by Lythgoe in 1937. The period of dark-adaptation was 12 hours or more. The retinae were washed in frog Ringer-Locke solution, shaken in 35 per cent w/v sucrose solution, and centrifuged. The outer limbs of the rods and cones floated undamaged in the sucrose, while the other cells of the retina were spun down. Details of each preparation are given in Table 1. The sucrose suspension of the end-organs was put into absorption cells the path-length of which was 5.0 mm. The change in the optical density of the suspension when it was exposed to light was measured at wavelengths 495, 505, 515 and 525 m μ . The maximum of the difference spectrum of the visual pigment contained in the cells of the suspension was found by interpolation of these results.

Table 1

Date of exp.	No. of frogs	Pigment density	Washings with sucrose	Centrifuged for	Depth of packed cell-layer		Pigment density (70- μ rod)	
					Haematocrit	Counting method		
Sept. 17	8	0.3240	3 of 0.5 ml.	10 min.	77 μ^*	77.5 $\mu^{\dagger}$	0.2950	0.2930
Sept. 23	5	0.3120	3 of 0.5 ml.	5 min.	70	55	0.3120	0.2970
Sept. 24	5	0.3230	5 of 0.25 ml.	5 min.	50.5	46.5	0.3080	0.2850
Sept. 25	8	0.4380	5 of 0.25 ml.	10 min.	96	79	0.3240	0.2890
							Mean 0.3100	0.2833
							S.E. 0.0068	0.0244

* Mean of three estimates. † Mean of four estimates

These results are not in accord with recent reports that in folic-acid deficiency choline synthesis from formate or methanol⁶ is decreased. These latter observations are therefore attributable to the known effect of the vitamin at the step leading to serine formation, thus limiting the extent of the subsequent choline synthesis. It is suggested that the well-known synergism between folic acid and vitamin B₁₂ in methyl economy may be explicable on the basis that folic acid inhibits methyl catabolism by better utilization of formate, and that vitamin B₁₂ promotes its anabolism from precursors besides being implicated in the transformation of choline to betaine and to methionine.

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The volume of the cells which contained this density of visual pigment was determined in two ways.

(1) Part of the suspension was diluted with saline and spun in a haematocrit tube. The end-organs sank through the diluted sucrose, and the percentage of solid in the suspension could thus be found. It is expressed in col. 6 of the table as the depth of the cell layer (in μ), in the 5-mm. absorption cell.

(2) Several different suspensions were examined under the microscope, and the diameters and lengths of 165 randomly chosen rod cells were measured. The mean volume of a rod (in the suspensions many were incomplete) was found to be 2,114 μ^3 . Samples of the suspensions the visual pigment density of which had been measured were put into Thoma counting chambers. Rod counts were made, in exactly the same way as red cell counts are made. Since the mean rod volume was already known, the percentage of solid in the suspension could be calculated. It is expressed in col. 7 of the table as the depth of the cell-layer (in μ) in the 5-mm. absorption cell.

In the last two columns of the table, the results of all the experiments are brought to a common basis by calculating, in each case, the density of visual pigment per 70 μ of rod-cell. The figure of 70 μ was chosen since, in the frog, the retinal rods are approximately 70 μ long.

Though the density of visual pigment in the suspensions could be measured very accurately, the measurements of the volume of the cells were not precise, and were made by two independent methods in order to examine their reliability. It can be seen that though the results of both methods are com-

parable, the values given by method (1) are slightly lower than for method (2). This might have been expected, since the suspensions contain a small proportion of cells other than rod outer limbs which will be spun down in the haematocrit, but disregarded in the counting method. Moreover, it is difficult not to neglect counting the smaller rod fragments.

Denton has recently measured the density of the visual pigment in the frog retina. In his method, photographs are taken of the rods 'end on'. The density of visual purple was about twice that found in the present experiments (Denton, personal communication). On the other hand, Dartnall's estimate, which was made from the results of measurements on solutions of visual purple, is comparable with the present result².

The difference between Denton's experiments and these is that in the former case the measuring light passed straight down the length of the rod cells, whereas in the suspensions (and in solutions of visual pigment) the rods (or the individual molecules) lie randomly in the absorption cell. The most likely explanation of the difference between the two estimates of the density *in situ* of visual purple in the frog rod is that, inside the end-organ, the pigment molecules are orientated, so that they absorb light most strongly when it passes down the optical axis of the cell, as it does when the retina is in place in the eye.

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Spectrum Intensities and Radio Frequency Noise in a d.c. Hydrogen Arc

In the course of experiments involving the use of a d.c. arc in hydrogen as a source for the vacuum ultra-violet¹, it was observed that the arc constituted a powerful source of radio-frequency noise.

To minimize interference with a nearby ionospheric recorder working on 5.8 Mc./s., efforts were made to reduce the noise generation. A shunt capacity of 0.1 μ F. was found to be effective; but its effect on the ultra-violet spectrum was marked. Fig. 1 shows two recordings of the spectrum of the positive column of the discharge in the 1200 Å. region, made with a fluorescence-sensitized photomultiplier, one with an unshunted tube, the other with the shunt. Tube current and gas pressure were the same in each case. The shunt reduced the voltage drop across the tube from 1100 V. to about 750 V. Striations visible without a shunt disappeared when it was inserted. The Balmer lines, especially $H\alpha$, appeared more prominently. The recorded spectra show that the intensities of the molecular lines are reduced by a factor of four or five times, and of the Lyman line at 1215 Å. by a factor of four. The radio-frequency current through the shunt was about 25 per cent of the magnitude of the d.c. arc current.

Fig. 2 shows measurements of the intensity of $L\alpha$, 1215 Å., with various shunt capacities placed across the tube, for different currents and different gas pressures. The arc current density was 4.7 amp./cm.² or a tube current of 150 m.amp. The linear response

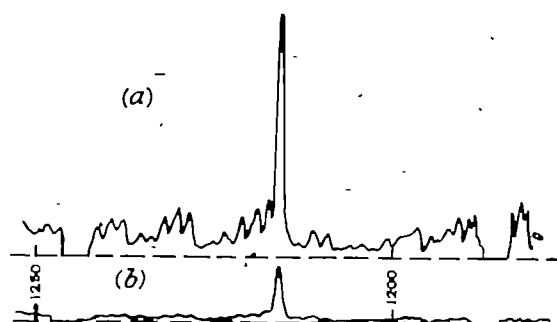


Fig. 1. Intensity distribution in hydrogen d.c. arc in the region of $L\alpha$, 1215 Å. Current density 5 amp./cm.²; pressure 0.6 mm. mercury. (a) Unshunted, striated; (b) shunted with 0.1 μ F., no striations.

of the detector was checked by varying the width of the slit in front of the photomultiplier cathode with the spectrograph grating adjusted so that the hydrogen continuum fell on the slit.

Because of the continued decrease in the intensity of $L\alpha$ as the shunt capacity was increased, it was thought worth while to try to estimate the change in noise output at a number of fixed frequencies at the same time. To this end, the standing current in the second detector of a communications receiver was balanced out and a milliammeter inserted to measure signal strength. With the gain control adjusted to keep within the approximately linear range of the detector, a calibration was obtained with a signal generator. The noise signal from the tube was then measured when it was shunted by a number of capacities, between 0.01 μ F. and 0.5 μ F., the aerial being adjusted to bring the received noise signal into the calibrated range with no readjustment of the receiver. This was done for each of five frequency bands, namely, 338 kc./s., 5.6 Mc./s., 9.0 Mc./s., 13.5 Mc./s. and 17.0 Mc./s., with the discharge current equal to 150 m.amp. and the gas

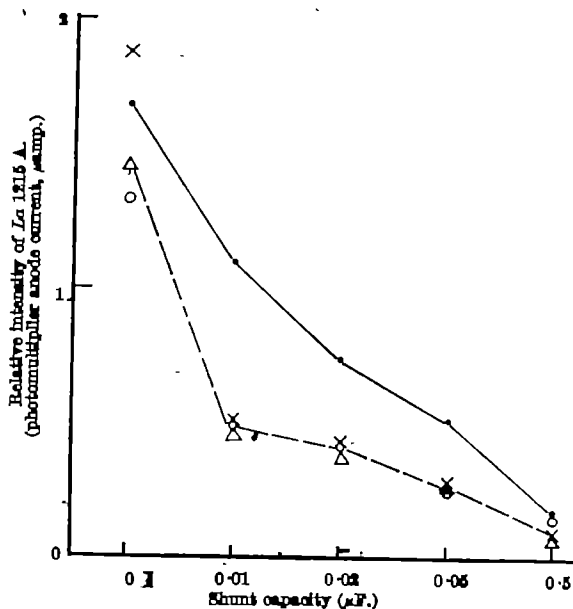


Fig. 2. Intensity of 1215 Å. vs. shunt capacity. The photomultiplier cathode was coated with sodium silicofluoride. The results for $p = 0.75$ mm. mercury correspond to a less efficient coating. $\circ$ — $\circ$, 50 m.amp.; $\times$ — $\times$, 100 m.amp. ($\times 2$); Δ — Δ , 150 m.amp. ($\times 3$). Pressure, 1.0 mm. mercury. $\bullet$ — $\bullet$, 150 m.amp. Pressure, 0.75 mm. mercury.

pressure 0.6, 1.0 and 1.3 mm. mercury. There was a decrease in noise output with increase in shunt capacity, the decrease being most marked for the highest two frequencies.

Since the anode of the tube is near the spectrograph slit, the positive column near the anode contributes most to the intensity of $\lambda 1215$ Å. Instability of the discharge makes observations with reversed polarity difficult; but it appears that when the cathode is nearest the slit the intensity is not very different.

It appears that, together with the disappearance of the striations and a decrease in radio-frequency noise, there is a reduction in the population of electrons having sufficient energy to excite hydrogen atoms. Large numbers of electrons with about 11 volts energy have been found in the striated column², and it is assumed that $\lambda 1215$ Å. results from the excitation of dissociated atoms. The intensity of the molecular lines, which have about the same excitation energy, should then decrease at the same time as the atomic lines. A connexion between the radio-frequency noise intensity and the energy distribution among the electrons, which is strongly suggested by our results, requires further elucidation.

We desire to acknowledge the financial assistance provided by the Research Grants Committee of the University of Western Australia and the help of Miss N. E. White in making some of the measurements. We are also indebted to Dr. R. L. F. Boyd, of University College, London, for discussion of these results.

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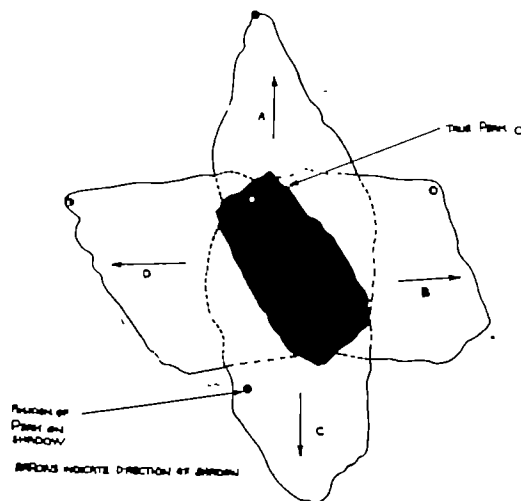
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Shadow Microscopy for Measurement of Height

TOLANSKY has described¹ an elegant method for observing, with a microscope, features of the three-dimensional profiles of particles and other small objects. For a particle of known geometry, it is correct to say that the height can be measured accurately



from the length of a shadow, which may be produced by Tolansky's method or by the usual metal shadow-casting technique. For a particle of irregular shape, however, such as a dust particle, height can only be determined approximately, for the following reasons, which are illustrated in the diagram: (i) the peak may not be in a position to throw the longest shadow; (ii) the plan position of the peak is not known, and consequently neither is that of the base line from which to measure the length of the shadow.

This problem has been investigated on a macroscopic scale, with lumps of coal and smooth weathered stones, 4–8 cm. in size. It was found that the best measure of height is given by $S \sin \theta$, where θ is the shadow angle and S is the distance from the mid-length of a particle, measured in the direction of shadowing, to the tip of the shadow. The percentage standard deviation, σ , of the estimate of height given by $S \sin \theta$ is well represented for both series, over a range of θ from 10° to 30° , by

$$\sigma = 20 (\sin \theta)^{-2.75}.$$

Details of this investigation will be published elsewhere.

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¹ Tolansky, S., *Nature*, 171, 364 (1953).

Two Half-shade Devices for Optical Polarizing Instruments

THE development of interference microscopes of the double-refracting type has stimulated a renewed interest in eyepieces having at their focal planes sensitive birefringent devices for increasing the accuracy with which forms of polarization can be determined. These devices usually employ a boundary or boundaries formed by one or more birefringent plate elements viewed through an analyser, and the difficulty arises of making boundaries sufficiently precise for the maximum sensitivity to be achieved. The present communication is a brief account of two rather promising solutions to this problem which have recently been investigated here.

In the case of the first and rather more elaborate solution, the boundary is artificially formed by double-refraction of the virtual image of a straight wire located at the focal plane of a positive eyepiece. The double-refraction is adjusted to produce a lateral displacement which is precisely the same as the diameter of the wire, resulting in the formation of a very perfect boundary between the two images of the wire. Since the two images are formed by double-refraction, they are polarized in mutually perpendicular planes and their intensity relationship is therefore a function of the polarization azimuth of the incident light, the intensity ratio being $\cos^2 \theta / \sin^2 \theta$, where θ is the angle which the incident vibration azimuth makes with the vibration direction of one of the two images. An analyser is consequently unessential; but the addition of one, so orientated that its vibration azimuth makes unequal angles with the mutually perpendicular vibration azimuths of the two wire images, results in an enhanced sensitivity which is very approximately proportional to the angular inequality.

The above arrangement seems immediately applicable to polarimetry and similar cases where it is required to determine azimuths of plane polarization; but it can also be applied to double-refracting instruments in which there are two beams polarized in mutually perpendicular planes if these are first circularly polarized by a quarter-wave birefringent retardation plate.

A similar arrangement can also be employed as a simple form of photometric eyepiece for microscopes, because the lateral doubling of the wire image is accompanied by a corresponding doubling of the object image, thus permitting photometric comparison between a sufficiently small isolated feature and its surround. The measurements can be made either by a goniometer-mounted polariser or analyser, using the above mathematical expression.

For applications to such instruments as double-refracting interference microscopes, however, the lateral doubling of the object image can be objectionable, in which case this may be avoided by introducing an initial compensatory form of double-refraction prior to the wire.

A convenient method for obtaining the double-refraction consists in interposing, between the positive eyepiece and the wire, a calcite plate cut parallel to the crystal cleavage. If the plate thickness is chosen to provide a lateral displacement slightly in excess of the diameter of the wire, the two images of the wire can be brought into perfect contact by rotating the plate in relation to the wire. The lateral displacement of such a plate is $0.11t$, where t is the thickness of the plate.

It has proved important to interpose between the plate(s) and the objective a lens to collimate the objective's back focal plane. Failure to take this precaution results in a lateral doubling of the Ramsden disk and consequent intensity variations accompanying the observer's head movements.

The second, and more recent, solution to the same problem was devised with the object of dispensing with double-refracting crystal elements. This is achieved by exploiting the mutually different elliptical polarizations resulting from reflexion at similarly inclined surfaces which are either differently metallized or metallized and total reflecting respectively.

In the preferred scheme, the light to be analysed is obliquely incident upon a dielectric/dielectric surface inclined beyond the critical angle and locally metallized with some such substance as aluminium, rhodium or silver. The unmetallized area then generates the elliptical polarization typical of total dielectric/dielectric reflexion, whereas the metallized area generates a different elliptical polarization typical of the metal employed. The locally metallized surface can therefore be employed as a half-shade device, very precise boundaries between the clear and metallized areas being readily attainable by localized removal of a pre-existing metallic coat. If removal is effected by a photographic etching process, comparatively complex patterns are possible; but, in practice, this is limited by the circumstance that the half-shade surface is steeply sloping and so cannot be focused simultaneously. Straight boundaries and hatches at right-angles to the plane of incidence on the half-shade surface can be satisfactorily obtained by mechanical removal.

A convenient way of applying this reflecting form of half-shade device to a double-refracting interference microscope is to form the localized metallization upon

the totally reflecting face of a normal inclined eyepiece prism and to examine this face through a low-power microscope. The principal plane of the prism should then be orthogonally disposed to the planes in which the two interfering beams are polarized. In the absence of any other suitable form of variable birefringent compensator, the phase angles can be measured by a goniometer-mounted analyser following a quarter-wave retardation plate on the viewing side of the prism.

For applications where the incident light consists of a single beam the polarization azimuth of which has to be measured, it is, of course, necessary to precede the prism with an additional quarter-wave plate the vibration directions of which are diagonally disposed to the principal section of the prism.

It has been found that, if aluminium is employed for the metallization, the coat must be thick enough to be virtually opaque, otherwise there is a strong absorption of one of the two plane-polarized components. On the other hand, rhodium coats have given satisfactory results at a transmission factor as high as 25 per cent for angles of incidence of the order of 45° .

F. H. SMITH

O. Baker of Holborn, Ltd.,
Metron Works,
Purley Way,
Croydon.
Nov. 11.

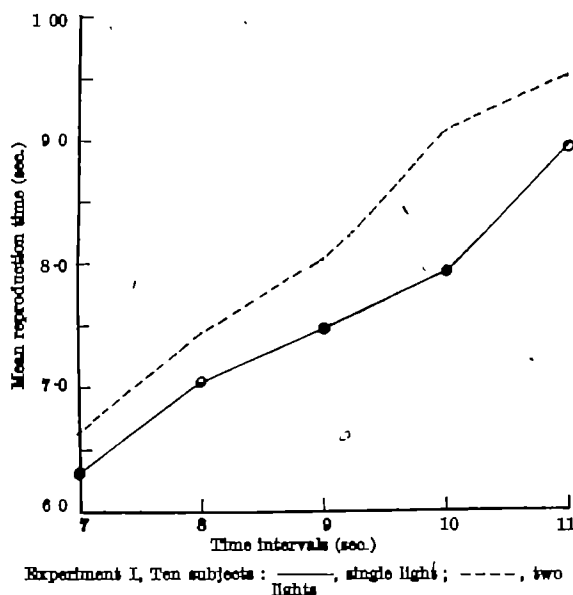
The Kappa Effect

THE new phenomenon in time judgment, described by Cohen, Hansel and Sylvester¹ and called by them the *kappa* effect, is independently confirmed in the following set of observations. These observations have been elicited under different conditions, by another experimental procedure, and over a further range of time-intervals than those described by the above authors.

The experiments were all carried out in daylight or with artificial light. Two 3.5-V. torch bulbs connected to a 2-V. accumulator were set on a table 4 ft. away from, and level with, the table at which the subject sat. These lights were operated by the experimenter so that they flashed at required intervals. The timing was mechanically controlled. The subject was provided with a morse key. The basic procedure was for the subject to reproduce the pause between successive flashes by holding down his morse key. Throughout the entire sequences, the time intervals used were from 7 sec. to 11 sec. inclusive. The mean reproduction time was recorded (1) when a single light, either A or B, was flashed successively, and (2) when two lights, either A then B, or B then A, were flashed. Both conditions were randomized, as well as the intervals themselves. However, the difference between any successive pair of intervals did not exceed 2 sec., so as to minimize any effect due to longer intervals following shorter intervals, or the converse. There were three separate experiments.

Experiment I. The two lights were set horizontally, such that each was equidistant from the subject, with a distance of 32 in. between them. Ten subjects were each given one series of sixty trials. There was a rest pause of five minutes after thirty trials.

Experiment II. Three separate series of measurements were taken at one sitting, with a pause of a



few minutes between the series. Each series consisted of twenty trials, with the lights placed 8 in., 16 in. and 32 in. apart respectively, in that order of presentation. The visual angle approximated to 10°, 20° and 40° for each series, as light A was held constant and light B varied, again in a horizontal direction. Light A was to the subject's left, while light B varied on each series in small steps farther to his right. The 32-in. position was the same as for experiment I. Seven of the previous ten subjects took part.

Experiment III. The two lights were set in line facing the subject; one light was 18 in. above the table and 32 in. behind the other. Eighty readings were taken in one series, a pause of five minutes rest being given after forty readings. In this series the subjects were instructed to fixate a point half-way between the two lights, in order to minimize eye-movements. In this experiment six new subjects were introduced.

The results are given in the accompanying table and graph. They seem to endorse the findings by Cohen *et al.* that a temporal interval between two successive flashes of light will seem longer as the distance between the corresponding flashes increases. The results of the first experiment were subjected to statistical treatment, and show a significant differ-

MEAN REPRODUCTION TIME IN SECONDS

Intervals in sec.	Experiment I 10 subjects	Experiment II 7 subjects	Experiment III 6 subjects
7	I 6.30 II 6.64	8 in. 5.93 16 in. 6.39 32 in. 7.07	I 6.40 II 7.09
8	I 7.13 II 7.44	8 in. 6.50 16 in. 7.15 32 in. 8.06	I 7.38 II 8.16
9	I 7.46 II 8.01	8 in. 7.06 16 in. 7.23 32 in. 8.23	I 7.74 II 8.64
10	I 7.93 II 9.09	8 in. 7.67 16 in. 8.51 32 in. 9.09	I 8.54 II 9.11
11	I 8.96 II 9.51	8 in. 8.39 16 in. 9.11 32 in. 9.49	I 9.04 II 9.71

I, Single light; II, two lights.

ence in the estimations made under the different sets of conditions. In all three experiments the results were unaffected by the order in which the lights were flashed in the vertical or horizontal planes.

The intervals used by Cohen *et al.* ranged from 0.6 sec. to 6.4 sec. They state that within their range the effect tends to diminish as T increases. The undiminished effect here shown to occur with larger intervals may be due to some peculiarity in the phenomenon, or to the fact that the previous experiments were done in the dark, or to other differences in the experimental conditions. Furthermore, in experiments I and III, and in one series of experiment II, the unit of distance was 32 in., whereas in the previous experiments the fixed distance was set at 1 ft.

Cohen, Hansel and Sylvester conclude that "the spatial and temporal components of the space-time events about which judgments are made are psychologically interdependent". That is the conclusion which must obviously be drawn here. However, it might be advantageous to pursue the matter in relation to phenomenological motion. It may well be that, in the kappa phenomenon, an 'imputed motion' is experienced by the subject which influences his temporal judgment.

I am indebted to Mr. B. M. Foss for advice during the experimentation; to Prof. C. A. Mace and Mr. Foss for their assistance with the communication; and to Prof. J. Cohen, of the University of Manchester, for further suggestions.

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¹ Cohen, J., Hansel, C. E. M., and Sylvester, J. D., *Nature*, 172, 901 (1953).

A Nickel-Gallium Superlattice (Ni₃Ga)

THE nickel-gallium system has been investigated by Hellner¹, who stated that the nickel solid solution extended to 28 atomic per cent gallium, while the lattice parameter increased to 3.591 Å. at the solubility limit. However, in the course of a systematic investigation of nickel alloy lattice parameters, which will be published in due course elsewhere, we have found a Ni₃Ga phase with the Cu₃Au superlattice structure. The nickel-gallium system is similar to the nickel-aluminium system² in that the ordered phase has a relatively small homogeneous range, while on the nickel-rich side a wide heterogeneous range is found at low temperatures, producing a considerable difference of lattice parameter of the two co-existing cubic phases.

A survey of known Ni₃X phases shows that when the radius-ratio ($r_{\text{Ni}}/r_{\text{X}}$) is equal to or less than 1.12, superlattice structures are formed by an ordering of the face-centred cubic nickel solid solution, and the temperature of formation is related to and increases with the radius-ratio.

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¹ Hellner, H., *Z. Metallkunde*, 41, 480 (1950).

² Bradley, A. J., and Taylor, A., *Proc. Roy. Soc. A*, 159, 56 (1937); Schramm, J., *Z. Metallkunde*, 33, 347 (1941); Taylor, A., and Floyd, R. W., *J. Inst. Met.*, 51, 451 (1952-53).

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, February 22

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE (in the Lecture Room of the Science Museum, South Kensington, London, S.W.7), at 8.30 p.m.—Mr. Lance L. Whyte: "The History of Natural Lengths".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. B. K. Dickie and Mr. C. M. Adcock: "Oil Production in the Nottinghamshire Oilfields".*

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, W.7), at 8.15 p.m.—Prof. K. de B. Codrington: "Between the Oxus and the Indus".

Tuesday, February 23

BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. B. B. Race: "Blood Groups".* (Twelfth of fifteen Lectures on "The Scientific Basis of Medicine".)

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, 1 Birdcage Walk, London, S.W.1), at 5.30 p.m.—Dr. H. Bardgett: "Carbonization of Blends of Coal to Produce Metallurgical Coke".*

UNIVERSITY OF LONDON (in the Anatomy Theatre, Communication Research Centre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. B. O. Oberry: "The Theory of Communication—Is Human Behaviour?".

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY, in the B.I.S.R.A. Laboratories Sheffield Group), Hoyle Street, Sheffield, S.1, at 7 p.m.—Dr. J. O. Hudson: "25 Years of Co-operative Research on Corrosion".

Wednesday, February 24

SOCIETY FOR ENDOCRINOLOGY (joint meeting with the ENDOCRINOLOGICAL SECTION of the Royal Society of Medicine, at 1 Wimpole Street, London, W.1), at 10 a.m.—Symposium on "The Technique and Significance of Oestrogen Determinations".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. K. W. Lockhurst: "The Society's Early Days: Some Light from Its Letters".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. A. H. Cook and Mr. H. I. S. Thirlaway: "The Geological Results of Measurements of Gravity in the Welsh Arden".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. A. H. Cook, F.R.S.: "Unsolved Problems in Food".

BRITISH SOCIOLOGICAL ASSOCIATION (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Prof. Alexander Macbeth: "Philosophy and the Social Sciences".

Thursday, February 25

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. A. N. Birch: "The Formation of Cracks as a Result of Plastic Flow"; Miss Helen Rae and Mr. A. H. Robinson: "Spiral Growth on Large Crystal Surfaces".

BRITISH GLACIOLOGICAL SOCIETY (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 5.30 p.m.—Dr. B. J. Mason: "The Growth of Snow Crystals in the Atmosphere and the Laboratory".

UNIVERSITY OF LONDON (at Senate House, London, W.C.1), at 30 p.m.—Prof. J. Van Den Brande (Ghent): "Some Aspects of Top Protection in Belgium".*

Friday, February 26

ASSOCIATION OF APPLIED BIOLOGISTS (in the Astrophysics Lecture Theatre, Imperial College, Imperial Institute Road, London, S.W.7), 11 a.m.—Scientific Papers.

BRITISH SOCIETY OF RHEOLOGY (at the Society for Visiting Scientists, Old Burlington Street, London, W.1), at 2.30 p.m.—Symposium on Friction in Relation to Rheological Properties".

ROYAL METEOROLOGICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion. Prof. D. R. Bates, Prof. V. C. A. Ferraro, Dr. R. M. Goody and Prof. R. W. B. Mansel: "The Composition of the Upper Atmosphere". Chairman—R. J. A. Ratcliffe, F.R.S.

ROYAL METEOROLOGICAL SOCIETY, SCOTTISH CENTER (in the Department of Natural Philosophy, The University, Drummond Street, Edinburgh 8), at 5 p.m.—Annual General Meeting. Dr. O. G. Sutton, F.R.S.: "Mathematics and Forecasting" (Presidential Address).*

BEDFORD CLUB (in Lecture Theatre 1, The New Chemistry Building, King's College, Newcastle upon Tyne), at 6.30 p.m.—Dr. F. P. Wyden, F.R.S.: "Adhesion and Surface Properties of Solids" (95th session Lecture).

INSTITUTE OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Sir Christopher Hinton (nuclear Reactors and Power Production) (James Clayton Lecture).

NORTH EAST COAST INSTITUTE OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Prof. Dr. Ir. W. P. A. van Lammeren and Dr. Ir. J. D. van Manen: "Correlation of Model and Ship's Trials in a Shallow Draught Rhine Vessel".

UNIVERSITY OF LONDON (at Wye College, Wye, near Ashford, Kent), at 8.15 p.m.—Prof. J. Van Den Brande (Ghent): "Agricultural research in the Belgian Congo".*

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. C. H. Andrews, F.R.S.: "The Common Cold".

Saturday, February 27

BRITISH PSYCHOLOGICAL SOCIETY, EDUCATION SECTION (at the Institute of Education, Malet Street, London, W.C.1), at 2.30 p.m.—Mr. Ben S. Morris: "Education and the Scientific View of Man and Society".

APPOINTMENTS-VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned.

ASSISTANT LECTURER IN CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (February 27).

METALLOGRAPHER, Experimental or Assistant Experimental Officer grade (with a good basic knowledge of metallurgy) to work on problems arising from research on novel metals and processes—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berks, quoting 2/103/52 (February 27).

SENIOR LECTURER (with an honours degree in chemistry, and preferably with industrial and teaching experience) in the DEPARTMENT OF CHEMISTRY—The Clerk to the Governing Body, College of Technology, Birmingham (February 27).

ASSISTANT EXPERIMENTAL OFFICER (with a pass degree or at least the general certificate of education to advanced level) in the HYDROLOGY SECTION—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (March 1).

SENIOR LECTURER or LECTURER IN PHYSIOLOGY at the University College of the West Indies—The Secretary, Senate Committee on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (March 1).

LECTURER in the DEPARTMENT OF CHEMISTRY, Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Wellington, March 5).

LECTURER (with an appropriate honours degree) in AGRICULTURAL ZOOLOGY AND PHYSIOLOGY OF FARM ANIMALS—The Secretary, School of Agriculture, Downing Street, Cambridge (March 5).

UNIVERSITY DEMONSTRATOR (with an honours degree in botany or agricultural botany) in AGRICULTURAL BOTANY, and a UNIVERSITY DEMONSTRATOR (with an honours degree in chemistry or agricultural chemistry, and preferably with experience of soil science) in SOIL SCIENCE—The Secretary, School of Agriculture, Downing Street, Cambridge (March 5).

LECTURER (preferably with special interest in strength of materials) in the DEPARTMENT OF MECHANICAL ENGINEERING—The Registrar, The University, Liverpool (March 6).

LECTURER (with an honours degree in mechanical engineering, and special experience of mechanical engineering drawing and design, theory of machines and strength of materials) in MECHANICAL ENGINEERING, at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, March 7).

SENIOR LECTURER in PATHOLOGY at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, March 7).

ASSISTANT KEEPER (a) (with first- or second-class honours degree or equivalent qualification in engineering or aeronautical science) in the DEPARTMENT OF AERONAUTICS AND SAILING SHIPS; (b) (with first- or second-class honours degree, or equivalent qualification in electrical engineering) in the DEPARTMENT OF ELECTRICAL ENGINEERING AND COMMUNICATIONS, Science Museum, London, S.W.7—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting 8.134/54 (March 11).

ASSISTANT LECTURER (with special qualifications in physical chemistry) in CHEMISTRY—The Registrar, The University, Manchester (March 12).

ASSISTANT EXPERIMENTAL OFFICER (with H.S.C. with science subject as principal subject or equivalent, or higher qualification, and a knowledge of radiography, photography, and photomicrographic apparatus and techniques) at the Ministry of Agriculture and Fisheries Veterinary Laboratory, Weybridge—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A 80/54A (March 13).

CHAIR OF EDUCATION—The Registrar, The University, Sheffield (March 13).

RESEARCH FELLOW IN CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (March 15).

TUTORIAL RESEARCH STUDENTSHIP IN MATHEMATICS (Pure or Applied)—The Principal, Royal Holloway College, Egham, Surrey (March 17).

TUTOR (honours graduate in science) in the DEPARTMENT OF EXTRA-MURAL EDUCATION, University of Glasgow, to conduct and organize classes in adult education—The Director of Extra-Mural Studies, 91 Oakfield Avenue, Glasgow, W.2 (March 20).

LECTURER or ASSISTANT LECTURER in the DEPARTMENT OF BOTANY—The Secretary, University College London, Gower Street, London, W.C.1 (March 31).

SENIOR LECTURER in INORGANIC AND PHYSICAL CHEMISTRY at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (March 31).

PROFESSORS OF MATHEMATICS, PHYSICS, CHEMISTRY, BOTANY or ZOOLOGY, GEOGRAPHY or GEOLOGY, at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Armidale, April 12).

CHEMIST (with an honours degree in chemistry, and with post-graduate experience in biochemistry)—The Director, Mauritius Sugar Industry Research Institute, Reduit, Mauritius (April 30).

EXPERIMENTAL OFFICERS (with pass degree in physics, mathematics or electrical engineering, H.N.O., or equivalent qualification) and

ASSISTANT EXPERIMENTAL OFFICERS (with G.O.B. at advanced level in appropriate subjects or equivalent) in the Department of Scientific and Industrial Research, Radio Research Station, Slough—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.82/43A.

INTERNATIONAL WOOL SHORTFIBRE RESEARCH SCHOLAR (with qualifications in physical chemistry) for work on research on the structure of the wool fibre—The Principal, Technical College, Bradford.

MASTER TO FRANCH CHEMISTRY to scholarship level—The Master, Marlborough College, Wilts.

SENIOR RESEARCH ASSISTANT (with good honours degree in engineering, practical experience and/or research training) in the DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—The Registrar, The University, Nottingham.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

- Institute of Personnel Management. Occasional Papers, No. 3: Statistics and Personnel Management. Pp. 16. (London: Institute of Personnel Management, 1953.) 8s. [1112]
- Institution of Gas Engineers. (19th Autumn Research Meeting, London, 24th and 25th November, 1953.) Publication No. 434: 14th Report of the Chairman's Technical Committee, 1953-54. Pp. 75. Publication No. 435: 20th Report of the Gas Education Committee, 1953-54. Pp. 30. Publication No. 436: Some Aspects of Coal Pyrolysis. By Sir Charles Ellis, F.R.S. Pp. 17. Publication No. 437: Institution Gas Research Fellowship. Interim Report: 1953-54. A Study of Fluidised Gasification. By B. H. Thompson and Dr. J. R. Garada. Pp. 52. Publication No. 438: Composition of Coal Tars. By Dr. D. McNeil and G. A. Vaughan. Pp. 23. (London: Institution of Gas Engineers, 1953.) [1112]
- Discussions of the Faraday Society. No. 15: 1953: The Equilibrium Properties of Solutions of Non-Electrolytes. Pp. 223+1 plate. (London: The Faraday Society, 1953.) 85s. net. [1112]
- The Nature Conservancy. Reports of The Nature Conservancy for the period up to 30th September 1953. Pp. 111+23. 1s. 3d. net. Report of The Nature Conservancy for the year ended 30th September 1953. Pp. 111+21. 1s. 3d. net. (London: H.M. Stationery Office, 1953.) [1112]
- Aero Research Technical Notes. Bulletin No. 181: Recent Developments in Ethoxylated Resins. By Dr. J. B. D. MacKenzie. Pp. 4. (Duxford: Aero Research Limited, 1953.) [1112]
- Building Research Station Digest. No. 60: Condensation in Domestic Chimneys. (Superseding Digest No. 5.) Pp. 4. (London: H.M. Stationery Office, 1953.) 3d. net. [1112]
- Notes on the Annealing and Pickling of Nimonic 75 and Nimonic F. Pp. 4. (Birmingham: Henry Wiggin and Co., Ltd., 1953.) [1412]
- Science Museum. The Conquest of the Air. By P. L. Summer. Pp. 22 (25 plates). (London: H.M. Stationery Office, 1953.) 1s. net. [1412]
- British Gelatine and Glue Research Association. Fifth Annual Report for the year October 1952 to September 1953. Pp. 19. (London: British Gelatine and Glue Research Association, 1953.) [1412]
- Bulletins of Marine Biology (Formerly Hull Bulletins of Marine Biology). Nos. 25 and 26, Vol. 4 (November 1953): Continuous Plankton Records: List of Records, 1950-53. By K. M. Raw. The Hardy Plankton Indicator and Sampler: a Description of the Various Models in Use. By B. S. Glover. Pp. 20+6 plates. (Edinburgh: Scottish Marine Biological Association, 1953.) 6s. [1412]
- National Research Development Corporation. Report and Statement of Accounts for the year 1st July, 1953, to 30th June, 1953. Pp. 11+19. (London: H.M. Stationery Office, 1953.) 9d. net. [1612]
- Flora of Tropical West Africa. Edited by Dr. W. B. Turrill and H. Milne-Redhead. Hypericaceae. Pp. 23. 1s. 8d. Pedalaceae. Pp. 23. 1s. 10d. (London: Crown Agents for the Colonies, 1953.) [1612]
- General Register Office. The Registrar General's Quarterly Return for England and Wales. Births, Deaths and Marriages. Infectious Diseases. Weather. Population Estimates. Quarter ended 30th September, 1953. (No. 419.) Pp. 28. (London: H.M. Stationery Office, 1953.) 2s. net. [1612]

Other Countries

- The Yokohama Mathematical Journal. Vol. 1, No. 1. (May, 1953.) (Published semi-annually, 2 issues per volume.) Pp. 130. (Yokohama: Yokohama Municipal University, 1953.) [712]
- Publicke Astronomisk Observatorie Oestskovenakke Akademiske ved, Omdrejov. Oslo 24: Katalog Omnoke Omdrejovskij Hrupol. (Oest Druha.) By J. Kloczek. Pp. 144. (Praha: Nakladatelstvi Oestskovenakke Akademiske Ved, 1953.) [1112]
- West African Institute for Oil Palm Research. Quarterly Progress Report (No. 6). (July 1st 1953, to September 30th 1953.) Pp. 19. (Benin City: West African Institute for Oil Palm Research, 1953.) [1112]
- British Guiana. Report on the Geological Survey Department for the Year 1952. Pp. 1+101. (Georgetown: Geological Survey Department, 1953.) 1 dollar; 4s. 2d. [1112]
- Annals of the New York Academy of Sciences. Vol. 56, Art. 5: Growth of Protozoa. By S. H. Hunter and 52 other Authors. Pp. 815-1094. 4.50 dollars. Vol. 56, Art. 6: The Relation of Lean Body Weight to Metabolism and Some Consequent Systematizations. By Albert R. Behnke. Pp. 1095-1142. 1.25 dollars. Vol. 57, Art. 3: Ion Exchange Resins in Medicine and Biological Research. By Harry Boboth and 25 other Authors. Pp. 61-324. 4.50 dollars. (New York: New York Academy of Sciences, 1953.) [1142]
- Chicago Natural History Museum. Fieldiana: Geology. Vol. 11, No. 7: Early Devonian Fishes from Utah. Part 2: Heterostrad. By Robert H. Denton. Pp. H+201-356. 1.25 dollars. Fieldiana: Zoology. Vol. 34, No. 21: A New Barbet from French Indo-China. By Austin L. Rand. Pp. 211-212. 10 cents. Vol. 34, No. 23: Marine and Fresh-Water Mollusks of the Solomon Islands. By Alan Solem.

Pp. 212-228. 25 cents. Vol. 35, No. 2: Placentation of a Primitive Insectivore Behnke's Gymnura. By Waldemar Meister and Dwight Davis. Pp. H+11-26+plates 4-9. 75 cents. (Chicago: Chicago Natural History Museum, 1953.) [12]

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 110, No. 7: Zoological Results of a Fifth Expedition to E. Africa. 7: Itinerary and Conclusions. By A. Loveridge. With Appendix on the Avifauna by O. W. Benson. Pp. 1+447-488 plates. (Cambridge, Mass.: Museum of Comparative Zoology, Harvard College, 1953.) [12]

Museum of Comparative Zoology at Harvard College. Brevia. No. 23: Notes on the Ant. *Leptothorax Obliquicollis* Cole (Hymenoptera: Formicidae). By Robert M. Gregg. Pp. 3. No. 23: A New Species of *Hypocnathus* from Panama. By Arthur M. Chickering. 18. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1953.) [14]

Comptes Rendus des travaux du Laboratoire Carlsberg. 86a. Physiologie. Vol. 25, No. 7: Cement Blocks, Heat-Stable Block for Asospore-Formation in Yeast. By Vagen Hartel and H. B. Mikkelsen. Pp. 219-240. 2 kr. 20 ore. Vol. 25, No. 8-9: The Growth of Maltose and Raffinose Fermentation in *Saccharomyces Cerevisiae* Strain Yeast Foam. By Oyvind Wings and Catherine Robert. Linkage Between Two Polymeric Genes for Raffinose and Sucrose Fermentation in Yeast. By J. L. Jinks. Pp. 241-258. 1 kr. 40 ore. (Copenhagen: Hn Commission Oles H. Hagerup, 1953.) [14]

Comptes Rendus des travaux du Laboratoire Carlsberg. 86b. Chimique. Vol. 23, No. 18: Stepwise Degradation of the Peptide Liberated in the Transformation of Ovalbumin to Flakalbumin. By M. Ottosen and A. Wollenberger. Pp. 452-478. 1 kr. 10 ore. Vol. 19, 20 and 21: The Significance of Concentration for the Rate of Ion Absorption by Higher Plants in Water Culture. 2: Experiments with Aquatic Plants. 3: The Importance of Stirring. 4: The Influence of Hydrogen Ion Concentration. By Carsten Olsen. Pp. 477-491. 1 kr. 80 ore. Vol. 23, No. 22-23: Quantitative Autoradiography Studies on the Amcoba *Oscia* with ¹⁴C. By Nils Arden. Only Chapman-Andersen, Holms Holter and O. V. Robinson. T. Films for Application Between Emulsion and Isotope-Containing Specimen in Autoradiography. By Olof Chapman-Andersen. Pp. 492-540. 3 kr. 25 ore. Vol. 23, No. 1: The Calcium Phosphate deposited in the Gomori Technique for Alkaline Phosphatase. By Carsten, Hjør Jensen and Gordon Johansen. Pp. 6. 50 ore. (Copenhagen: Hn Commission Oles H. Hagerup, 1953.) [14]

Tanganyika: Geological Survey Department. Short Paper No. 1: The Geology of the Minkuru Coalfield (Songea District). By D. H. Harkin. (With appendices by D. A. Harkin, H. G. Burks and J. Walke. Pp. vi+66+5 plates. 7/50 shs. Geological Map: "Mkwapa-80-837/MI." (Extension of the map contained in Short Paper No. 1. By Dr. B. N. Temperley. (Dar es Salaam: Government Printer, 1953.) [144]

Sixty-Ninth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution. 1951-1952. H+80. (Washington: Government Printing Office, 1953.) [14]

Smithsonian Institution. Bureau of American Ethnology. Bulletin 151: Anthropological Papers Numbers 23-43. Pp. ix+508+5 plates. Bulletin 154: River Basin Surveys Papers. Inter-Agency Archaeological Salvage Program. Numbers 1-6. Pp. xviii+238+6 plates. 1.75 dollars. Bulletin 155: Prehistoric Settlement Patterns in the Viré Valley, Peru. By Gordon R. Willey. Pp. xxii+58+6 plates. 4 dollars (cloth). (Washington: Government Printing Office, 1953.) [141]

Smithsonian Institution. Institute of Social Anthropology. Publication No. 15: Indian Tribes of Northern Mato Grosso, Brazil. By Károlyi Öberg. With Appendix: Anthropology of the Umotheni, Nambikwara, and Iranxe, with Comparative Data from other Northern Mato Grosso Tribes. By Marshall T. Newman. Pp. viii+144+11 plates. 1 dollar. Publication No. 16: Penny Capitalism: a Guatemalan Indian Economy. By Sol Tax. Pp. x+230. 1.75 dollars. (Washington, D.C.: Government Printing Office, 1953.) [151]

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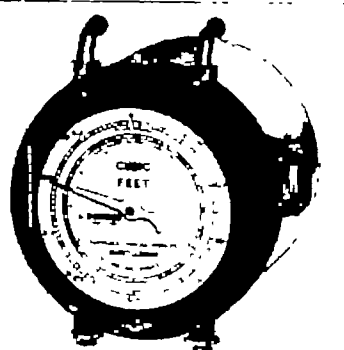
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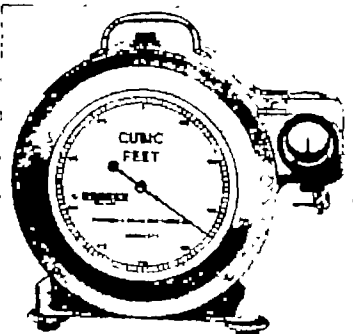
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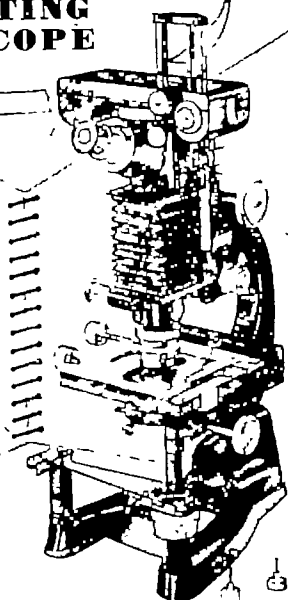
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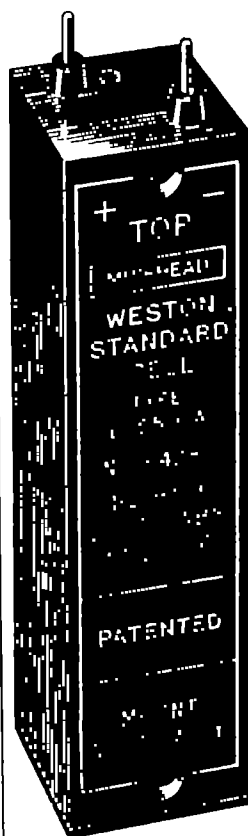
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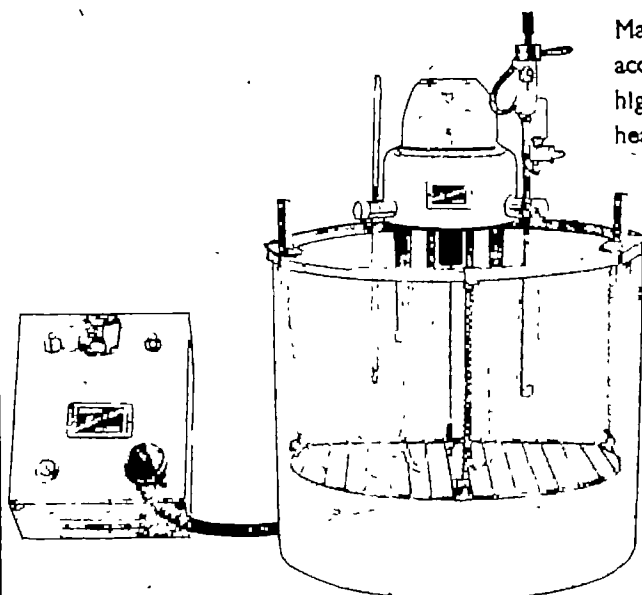
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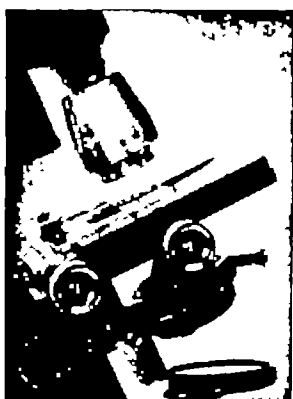
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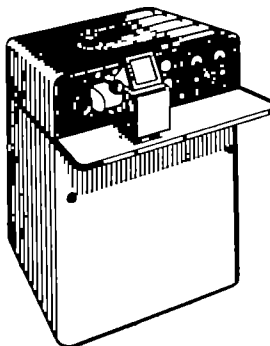
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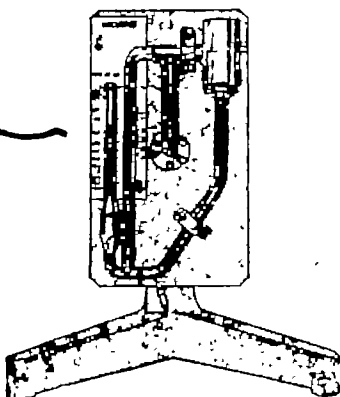
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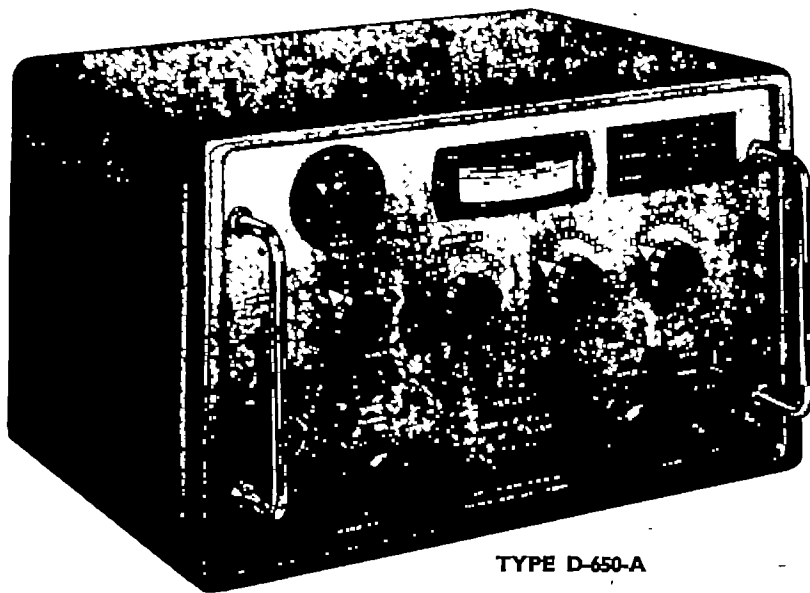
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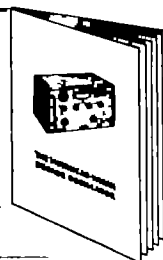
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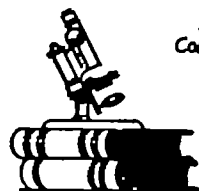
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SCIENCE IN EDUCATION AND INDUSTRY

RECENT discussions on the shortage of science teachers in schools, and also on the parallel shortage of scientific workers, technologists and technical workers in industry, the research associations and Government experimental stations in Great Britain have produced few positive suggestions to meet the situation. Probably the first step required is to complete the man-power survey which the Advisory Council for Scientific Policy initiated when it appointed its Committee on Scientific Man-power in December 1950, and to concert the policy and action, especially in regard to technological education and the shortage of science teachers, to which its report of March 1952 pointed. Here the Lord President of the Council manifestly has both the responsibility and the opportunity for initiative. To him and to the Chancellor of the Exchequer, rather than to the Minister of Education, we might also reasonably look for efforts to influence the choices which are made of careers by boys and girls at the ages of fifteen or sixteen, or even the subsequent choice of university faculties, including the choice of technology rather than science itself. Drive and imagination are required to arouse the interest of young people, and to overcome the lack of awareness or appreciation of the opportunities and importance of both a scientific and a technical education. These qualities are more likely to be found in quarters fully aware of the vital need for scientists and technologists, and the limitations on progress which their absence must place in every sector of the national economy.

Such measures are essential whatever means are adopted for the expansion of technological and technical education. Although an improvement in the supply of science teachers in the schools would help, it is not by itself likely to ensure that there are no places in the existing schools of science, engineering and other technologies unfilled for lack of well-qualified applicants, much more in the expanded schools which are so clearly desirable. Moreover, such measures merge almost imperceptibly into those required for determining the wisest deployment of our scientific and technical man-power, on which the inquiry already suggested could throw further light.

The shortage of science teachers of high quality is in fact only one, though perhaps the most critical and prominent, of our failures to secure the most effective deployment of our scientific man-power. The realization of the threat that this shortage offers to our national welfare should lead to much more drastic and far-reaching action than that contemplated in the report from the National Advisory Council on the Training and Supply of Teachers. It is right and necessary that all possible measures should be taken not only in the schools, but also in the universities, in industry and in Government departments, to see that trained scientists are not employed on duties for which less highly trained men or women are competent, as it is also to see that their services and

advice are not wasted by managements or administrators incapable of assessing scientific and technical factors in a situation. But inquiry should go further into the real reasons for the shortage.

Apart from the economic reasons, the stress which is now being laid on the importance of opportunities for research in schools lends some support to a recent suggestion of Mr. Eric James, High Master of the Manchester Grammar School, that we have invested research with a prestige which is destructively high, since it may be attracting all the ablest scientists from the task of educating the next generation of investigators. Whether or not that view be correct, that it should be advanced suggests caution in dealing with the situation on purely economic grounds. If purely financial proposals could be found which did not involve awkward repercussions, they might still offer no complete solution by themselves. Even diagnosis is as yet incomplete, and meanwhile energetic action along all possible lines to alleviate the situation, including grappling with the thorny question of retirement, is imperative.

Neither that action, nor the working out on the basis of further inquiry of the long-range solution to deal with real causes, can be left to the Minister of Education. Moreover, there is linked with it the whole question of the nature of science teaching in the schools and the use to be made of science graduates as teachers. If more of the graduates in arts, for example, left the universities of Britain with some sound knowledge of general science, they might well be qualified to assist in the general science teaching which is so desirable for the ordinary citizen, whether or not he proceeds beyond the grammar school or technical school level. That in itself, by facilitating the absorption of science into the general culture, should tend to further the supply of promising students for the technical colleges and the university schools of science or technology, and it should also assist the graduate science teachers to concentrate more on the sixth forms or the teaching of those with a scientific career in mind.

No more need be said here to illustrate the complexity of the relations in these questions of training and deploying our scientific and technical manpower, and the imperative need not merely for more precise information but still more for close co-ordination between all the Ministries concerned and between industry, the universities, the technical colleges and the schools. Much more clear thinking is required about the respective functions of these institutions. Although the nature of professional training and the place where it should be given—or at any rate completed—may not be susceptible of a general interpretation, at least ideas could be formulated clearly enough for some agreement to be reached between, say, the universities, the colleges of technology, the research associations, and professional institutions in regard to a particular industry, which would permit expansion being planned on a rational and a national basis. The universities, too, play a decisive part in determining the use made of science teachers in the schools, and a constructive approach from them, as the Advisory Council on the Training and

Supply of Teachers obviously recognizes, could have a decisive influence in improving the situation.

Finally, as has already been indicated, the supply of man-power cannot be considered apart from its deployment. The nature of that deployment can markedly affect the resources available for training, as can be seen, for example, in the concern freely expressed by the universities, both in the United Kingdom and in the United States, regarding the sponsoring of research by Government departments. Clearly, the universities would be quite right to set a strict limit to the research enterprises, even in fundamental science, for which they accept responsibility even at Government behest, both because of possible adverse effects on their teaching responsibilities and because the balance of research effort may be seriously distorted. Moreover, while the possibilities in the way of research at the higher technological institutions or of technical colleges have scarcely been explored, there are limits to what is possible here, and the final word must rest with the institutions themselves. A sound judgment would almost certainly be facilitated by the advice and help which the University Grants Committee, or a technological education sub-committee of that body, could give. The complexity of all these relations is sufficient reason for urging once again the importance of placing the responsibility for higher technological education in the hands of the same body that bears the responsibility for the broad supervision of university education.

The question of technical education and of the technical colleges would still remain. While that should no longer be the responsibility of the Ministry of Education or of the local education authorities, it is less clear where the responsibility should be placed. Apart from the educational responsibilities of the research associations, the increasing importance of association of industry with technical education lends support to the view that the Department of Scientific and Industrial Research should be more closely associated with technical education itself. The view which the Advisory Council for Scientific Policy has taken of its responsibilities towards industry and towards education suggests that that body might possibly prove the appropriate authority for watching over the development of the technical colleges in the interests of the nation.

The importance of securing closer association of industry in all these developments can scarcely be over-stressed. It is already fully recognized by the Advisory Council for Scientific Policy, no less than by that for Scientific and Industrial Research, that the effective utilization in industry of existing knowledge, let alone the wider prosecution of industrial research, depends on the presence in industry, and especially at the management-level, of those capable of appreciating the significance of scientific work and the bearing of particular advances on their own industrial activities. This is not simply a matter of education for management: it is a matter of technical and scientific education, of providing industry—and especially the smaller firms—not so much with first-class technologists, as with the larger

numbers of technicians and craftsmen, of men and women trained to a level which enables them to carry out competently the manifold tasks in industry for which a less rigorous training in science and technology is entirely adequate. The problem is not one of producing more scientists or technologists of the very highest class, but of training in science and technology many more of the ordinary school-leavers who could profit by such training though not necessarily to honours degree level.

There is a further reason for welcoming closer association with industry. Developments like these which promote the right balance between technical, technological and university education in the light of the known needs of industry in Great Britain should also foster the spirit of enterprise within industry, without which development may well be sterile. The warning which Sir Henry Tizard gave in his Messel Memorial Lecture on this point needs to be remembered. While the Government is justified in extending the life of the National Research Corporation for a further five years, the latest report of the Corporation gives no clear evidence as to the permanent value of the Corporation in industrial development. At least it can be said it will not be healthy if the existence of the Corporation encourages industry to leave to Government departments judgments and decisions for enterprises in which the initiative properly rests with industry itself. Nor should it be thought that resistance to increased industrial efficiency and productivity comes solely from the management level of industry; for the Labour Party recently attempted to write into the Iron and Steel Bill a provision that no change in the technique or geographical pattern of industry should be allowed if it renders any workers redundant, or down-grades their job or causes them to move to a new locality.

The bearing of technical education, and indeed of the content of general education, on technological change and productivity, so well brought out in the reports issued by the United Nations Educational, Scientific and Cultural Organization, could scarcely be better emphasized. While, therefore, the Government's new policy towards the Department of Scientific and Industrial Research, like the new arrangements for the development of atomic energy, promises substantial benefit to Britain's economy, the realization of that promise depends on wider considerations. It depends in the first place on the Government utilizing the opportunities thus afforded to concert a real policy for scientific and industrial development, and especially for scientific and technical man-power. Of the many facets of that policy, none is at present more important than the handling with vision, with energy and decision, those questions of the supply of science teachers and the balance of technical, technological and university education. Nor will it suffice to secure adequate numbers of scientists, technologists, technicians and craftsmen, managers and administrators capable of identifying the problems to which scientific or technical knowledge can contribute, of assessing the scientific and technical aspects of a situation, and of appreciating

the significance of new knowledge. To secure the full and efficient use of such men in industry, Government establishments or public bodies, involves not only eradicating the idea that scientists and technologists must always remain such and be debarred from managerial responsibility; it may well involve also a new outlook and attitude in the Government and in industry at all levels, such as can come not simply by encouraging more people to take up scientific studies, but by a radical change in the content of general education and the teaching of science.

AFRICA SURVEYED

Africa

A Study in Tropical Development. By Prof. L. Dudley Stamp. Pp. vii+568. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 68s. net.

PROF. DUDLEY STAMP fears that people "full of enthusiasm but lacking both knowledge and wisdom" will rush in to the salvation of tropical Africa: and so he has attempted, dispassionately and objectively, "to consider its geographical background as an environment for human activity and to study the responses which have been evoked from its African inhabitants and those who, in the last few centuries, have penetrated its fastnesses and molded its fortunes". His special concern has been to emphasize those physical facts of the environment which exercise a permanent and continuing influence and to concentrate more upon major problems than upon local details.

British readers must remember that the book is meant primarily for an American public. This helps to explain not only the high cost of the volume and the excellent range and quality of its 234 illustrations, but also the statement on the dust-cover that "America has a very special interest in Africa" and the fact that as many words are devoted to Liberia as to the larger and more populated territories of Kenya or Uganda.

The volume is divided into three parts: "The Continent"; "The Countries and Regions"; and "Africa Today". Two hundred pages are given to the first section on the whole continent; about three hundred to the regions, of which Prof. Stamp recognizes ten; the final section is but a brief and disappointing chapter incorporating some recent bibliographical and statistical information.

In the first part, Prof. Stamp has conveniently brought together much that is common knowledge about the opening-up of Africa and its human and physical geography, and has illustrated it by a valuable series of maps and diagrams. He has, moreover, incorporated much that is new, notably in the chapters on climates and soils, while in the chapters on pests and diseases and on transportation he has dealt with subjects that in Africa have too often been inadequately considered.

The regional chapters begin with a reminder that "nearly every country in the world has its own individuality". It is expecting much of any writer (even though he be of Prof. Stamp's eminence) to convey in words, diagrams and photographs what a famous French geographer called 'the personality of regions'; the more so in a land-mass as vast and as politically diverse as the continent of Africa. Inevit-

ably a great deal of the information must come from secondary sources and should be acquired and sorted over a longer period than the author has been able to devote to the preparation of this volume. Prof. Stamp is much more convincing when he writes of what he knows at first-hand—Nigeria, for example, or the Union of South Africa—than when he is dealing with certain other areas where the facts seem unrelated and where there is no proper emphasis on the special problems of the moment. In places the juxtaposition of the generalized and the detailed is confusing. In the chapter on East Africa, for example, a general map with relief and place-names (inferior to many atlas maps) and a crude map of population distribution (with 10,000 persons represented by a single dot) are placed alongside reproductions of excellent previously published maps of the topography and vegetation of Mount Kilimanjaro and of types of land occupation in Tanganyika Territory.

Geographers rightly emphasize that their prime concern is with regions as they are: but in a continent the political and economic future of which is of such consequence to the rest of the world, might not more space be devoted to a consideration of some of the prospects of to-morrow? For example, what is Prof. Stamp's assessment of the possibilities of industrial development in the Rhodesias if the water-power of the Kafue river or at the Kariba gorge is harnessed? How will the dams at the Owen Falls in Uganda or on the Volta in the Gold Coast affect the economies and the peoples of East and West Africa, respectively? This book gives no real answer to questions such as these. On the other hand, extended comments are given on development schemes that have proved unsuccessful, notably the East African groundnut scheme, though not everyone will accept all that Prof. Stamp has written about the reasons for its failure. There is, unfortunately, nothing on the geographical and economic background to Central African Federation, nor of the difficulties that geography presents to the proponents of *apartheid* in the Union of South Africa.

But to emphasize such inadequacies and omissions as there are, or to refer to any errors of fact or shortcomings of style that an individual reader may note, would be ungenerous of a fellow-geographer who is impressed by Prof. Stamp's amazing capacity for the condensation and collation of so much information of a highly diverse, and sometimes technical, nature into a reasonable compass. For all its 568 pages, this is a short book compared with other comprehensive volumes on Africa, such as Lord Hailey's "African Survey" (1,837 pages) and the same author's "Native Administration in the British African Territories", the five volumes of which contain nearly 1,400 pages. Prof. Stamp does not claim originality for his latest book: it is essentially a compilation in which attention is very properly directed towards many recent papers in geographical and other periodical literature. For geographers who find it hard to keep afloat in this gathering spate, the book will be invaluable: indeed, for all concerned with Africa, it will become a most useful work of reference. It will do good because it reminds us, as Prof. Stamp puts it, that "throughout much of Africa, especially tropical Africa, the course of man's life is still dictated in large measure by the physical environment". It challenges us all to an investigation of the many problems of Africa to-day on the broadest possible basis, both scientific and political.

R. W. STEARL

NATURALLY OCCURRING DERIVATIVES OF NAPHTHALENE

Elsevier's Encyclopædia of Organic Chemistry
Edited by F. Radt. Series 3: Carboisocyclic Compounds. Vol. 12B: Naphthalene, A. No. 5: Compounds containing One Naphthalene Nucleus; Naphthoquinones and other Polyketohydronaphthalenes; pp. xxx+2717-3260+Ind. 44; £19. No. 6: Compounds containing One Naphthalene Nucleus, Carboxylic Acids (CO₂H in Side Chain); pp. xlviii+3261-3964+Ind. 78; £24 10s.

(Amsterdam and New York: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1952-53.)

THE compilation of Vol. 12B of this work, dealing with naphthalene and its derivatives, is proving an exceedingly formidable task. Section A, comprising compounds containing one naphthalene nucleus, has not yet been completed, although, with the two parts now under review, six parts have been issued, with nearly four thousand pages.

The first of the two parts (No. 5) is concerned largely with the naphthoquinones and their functional derivatives, their homologues, halogen derivatives, nitro-, amino- and azo-derivatives, followed by a large section which describes in detail the hydroxy-naphthoquinones and their derivatives. To the natural-product chemist the latter section is the more interesting, dealing as it does with natural pigments including lawsone, juglone, phthiocol, plumbagin, shikonin and alkannin, Hooker's lapachol, and the very remarkable echinochromes and spinochromes. Echinochrome A is said to activate the sperms of sea-urchins in a concentration of 1 in 2.5×10^5 , which probably represents the highest dilution in which any form of biological activity has been observed. Physiological properties are described for quite a number of substances listed in both parts of Vol. 12B, and in the case of the naphthoquinone derivatives there is frequent reference to their use in analytical chemistry. A ten-page section discusses compounds with vitamin K activity. The reactions of the quinones include many leading to complex heterocyclic structures, which are formulated. 4-Benzyl-1:2-naphthoquinone is one of the few *ortho* quinones which have been used successfully in the Diels-Alder reaction. A few synthetic dyes are described, such as α -naphthol blue, naphthazarin and naphthopurpurin, but the bibliographies contain no reference to patent specifications. Most of the quinones treated are derived from 1:2- or 1:4-naphthoquinones; there is a brief description of 2:6-naphthoquinone, and a short section dealing with diquinones (1:2:3:4- and 1:4:5:8-). Hydronaphthalenes are represented by their few known polycarbonyl derivatives.

The second part (No. 6), in a sense, is not concerned with naphthalene chemistry at all, as it deals with open-chain carboxylic acids which happen to have naphthyl or substituted naphthyl substituents. Associated hydronaphthyl carboxylic acids are also treated. Carboxylic acid derivatives, for example, nitriles and amides, are included although the derived acid may be unknown. Lactones are described, in spite of their heterocyclic character, even if the related hydroxy-acids are unknown. Naphthoic acids and their derivatives will doubtless be dealt with in the next part. The majority of the acids included in the present part are monocarboxylic acids; but brief

sections describe also some di-, tri- and tetra-carboxylic acids. The most important natural product treated is *santonin*, and the section which describes this lactone and its derivatives and transformation products amounts to more than a hundred pages. *Artemisin* and *alantolactone* are dealt with in some detail, and it is a little inconsistent that *pseudosantonin* is dismissed in a dozen lines. The reason is that its structure was unknown when the material was assembled for this part.

The features with which users of the "Encyclopedia" are already familiar are found again in both parts. There are the usual clear type and excellent printing, the editorial footnotes commenting on ambiguities or wrong assignments of structure (in one case, attention is directed to the fact that the analysis figures do not fit the proposed formula), the elaborate reaction schemes showing the interrelationships of complex natural products (for example, *juglone*, *lapachol*, *santonin* and *artemisin*), and the inclusion of completely up-to-date references to important papers giving structural information. There is comprehensive literature cover up to 1944. A useful feature is the indexing under specific headings of anthelmintic and growth-promoting compounds (for example, 1-naphthylacetic acid) and natural products.

The high standard of production has been well maintained, and organic chemists will be grateful to the Elsevier editorial staff for this further contribution to the bibliography of organic chemistry.

J. W. COOK

NUCLEAR PULSE AMPLIFIERS

Signal, Noise and Resolution in Nuclear Counter Amplifiers

By A. B. Gillespie. (Electronics and Waves Series.) Pp. xii+155. (London: Pergamon Press, Ltd., 1953.) 21s.

AS its title implies, this book does not attempt to deal exhaustively with the design of amplifiers for use with nuclear counters, but restricts itself to some important features in which such amplifiers differ from those used in other applications. These differences arise mainly from the fact that a nuclear counter amplifier receives its input signal in the form of a charge and delivers a pulse of which the peak amplitude must be linearly related to the magnitude of this charge, but the shape is of little interest.

In practice the shape and duration of the output pulse is determined almost entirely by the amplifier constants and scarcely at all by the input signal. The signals usually occur at random times, so that it is not possible to resort to some of the methods for improving the signal-to-noise ratio which are employed in the radar field.

After a brief introduction, the author discusses, in elementary fashion, the nature of the signal produced by an ionization chamber and the relation between this and the amplifier time-constants. The next section discusses the various sources of noise in the amplifier and how these depend on circuit design and valve-operating conditions. This is followed by a detailed discussion of signal-to-noise ratio and how this is influenced by the amplifier parameters. The important point is made that usually a compromise must be sought between

signal-to-noise ratio and time resolution. Thus, in comparing the signal-to-noise ratios provided by different systems, the results will be misleading unless the time resolution of these systems is also taken into account. This has not been appreciated by some earlier writers. The next section shows how amplifier noise affects the accuracy of counting experiments. Finally, proportional counters and scintillation counters are considered. In these cases amplifier noise is seldom a problem; but similar effects may be produced by a background of unwanted radiation reaching the counter. Theoretical treatment of this presents difficulties which the author has not been completely successful in overcoming, but useful data are presented.

There is a danger that a book of this nature may become excessively mathematical. This has been successfully avoided by the author, who banishes most of the mathematics to the appendix and relies on physical arguments supported where necessary by theoretical and experimental results. As a result, the text is lucid and easy to read, though one or two grammatical lapses can be detected.

One may question the author's wisdom in taking into account at the outset the finite time of rise of the ionization-chamber pulse. This leads to rather complex expressions in the early part of the book. It might have been simpler initially to assume a step-function input signal and to have derived expressions for signal-to-noise ratio on this basis. It would then not be difficult to show how these results are modified in cases where the pulse-rise time is not short compared with the amplifier time-constants.

Because of its mathematical and practical simplicity, the author has given most consideration to the case where the upper and lower limits of the amplifier pass-band are determined by single resistance-capacity time-constants having values T_1 and T_2 respectively. He rightly concludes that for best results $T_1 = T_2$. These calculations assume that all the other time-constants limiting the high-frequency response of the amplifier are short compared with T_2 , and it might be inferred that this is a necessary condition for best signal-to-noise ratio. This is not the case, for it can be shown that if the upper-frequency limit is determined by many time-constants all equal to T_2 , the signal-to-noise ratio for a given resolution time, far from being worse, is actually slightly improved. Thus, in an amplifier in which T_1 and T_2 are made adjustable, the most economical design is one in which the high-frequency time-constants of all the stages are equal to the smallest desired value of T_1 .

The deliberately limited scope of the book excludes a good deal of information which would be of value to the designer of nuclear counter amplifiers, such as the choice of the most suitable type of negative-feedback circuit and its design to give stable gain with a monotonic step-function response while making best use of the gain band-width properties of available valves. The reaction of pulse amplifiers to large overload pulses is also of importance. While a fair amount has already been written on these subjects, the last word has yet to be said.

Within its scope, however, the book is an excellent one and contains many theoretical and experimental results which have not previously been published. The agreement shown between theory and practice is, in most cases, remarkable. This is a tribute not only to the author's theoretical analysis, but also

to the skill and care with which the experimental measurements of noise must have been made. To obtain reproducible results from such measurements, especially at low frequencies, is something of an achievement.

The designer of nuclear pulse amplifiers will find the book valuable, if he accepts the fact that the problems considered are by no means the only ones he will encounter. The book will also be helpful to nuclear physicists and others who may have to undertake experiments the success or accuracy of which is threatened by the presence of noise or background radiation.

E. H. COOKE-YARBOROUGH

HISTORY OF SCIENCE

A History of the Sciences

Main Currents of Scientific Thought. By Dr. S. F. Mason. Pp. viii+520. (London: Routledge and Kegan Paul, Ltd., 1953.) 28s. net.

NO one can to-day lament a deficiency of general histories of science. Dr. Charles Singer's "Short History" and Sir William Dampier's "History" were early efforts in this field, of which new editions are still in demand. Dr. W. P. D. Wightman's "Growth of Scientific Thought" is a more recent endeavour to cover similar ground, and now there is this fresh survey from Dr. S. F. Mason, of Oxford, which extends from the ancient empires to Lysenko. This is longer, and more complete in factual detail (especially for the modern period), than any of its predecessors, and on many points the structure of the book shows, very properly, the influence of important modern investigations. The indebtedness of Hellenistic science to its precursors among the Egyptians and Babylonians, as well as among the pre-Socratic Greeks, is well brought out. China and India form the subject of separate chapters in which their contributions to the West are analysed. These are important additions to a general history of science; but they are not without corresponding losses, since Islam is dismissed in six and a half pages, and medieval Europe in sixteen. Dr. Mason then devotes about two hundred and ten pages to the period 1500-1800, in which the extent to which the 'mechanical philosophy' permeated scientific thought is rightly emphasized, and slightly less space to the nineteenth and twentieth centuries. The main criticism of this balance of the attention given to the main stages of scientific development concerns the very recent period, for here Dr. Mason might be judged to linger excessively on topics which have been dealt with already in a multitude of publications.

On other points, however, Dr. Mason adopts a more conservative attitude. It is a little surprising to be told that Aristotle's zoological works are of later date than his physical (p. 31); that "medieval craftsmen contributed the experimental criterion to the scientific method" (p. 95); that Boyle "gave the modern definition of a chemical element" (p. 190); and that "When natural philosophy began to show signs of stagnation towards the end of the seventeenth century the nascent science of chemistry suffered a serious reverse" (p. 241). On this last question especially, the complete omission of the fundamental work of Mme. Metcalf from the bibliography is surely significant. But generally the author proves himself

well acquainted with the present flood of research on the history of science—though he lists few non-English publications.

This has helped him to build up a detailed story, especially from the sixteenth century onwards—that is, about four-fifths of the volume. He has assembled a much greater wealth of information on many subjects (for example, science and religion at the time of the Reformation; embryology; and the cell-theory) than is available in any comparable book. To have done so is probably its highest merit, and it is regrettable that the entire lack of illustration must render some of the material unintelligible to readers to whom such matters are unfamiliar. Illustrations would inevitably have increased a very moderate price; but they are ill spared. History, however, is not simply information; the facts must be interpreted. A single theme runs through Dr. Mason's book—that modern science is the product of the combination of a craft and a philosophic tradition with regard to the study of Nature—and it seems that he regards the former as the more important. Thus, he says, the Michurin school of Soviet biologists, of whom Lysenko is the contemporary leader, arose from the work of a practical plant-breeder, while Mendelian genetics sprang from problems in the theory of biology and is largely an academic subject. This he regards as another example of the "difference in outlook between the craft and the scholarly traditions, which has existed throughout written history". The remark may be true, but scarcely in the sense that Dr. Mason intends. Nevertheless, his theme is an important one, for the instruments and experimentation of science have often depended on the resources of craftsmanship, and, more than this, the practical and pragmatic outlook of the craftsman has reinforced on occasion the analytical mind of the philosopher. Yet it is not enough to suppose that this is the whole of science, or that its history is solely concerned with tracing how the latter has successively given place to the former. It is therefore unfortunate that Dr. Mason has not given a fuller account of the way in which he supposes the 'craft' and 'philosophic' traditions to have interacted to yield science, which is so clearly distinct from either. At least in some instances this seems to lead to doubtful propositions, as when he remarks that "a barber-surgeon . . . might be a skilled sectionist and know intimately the anatomical structure of the human body". For while it may be convenient to his thesis to distinguish between this 'craftsman' and the academic Galenist, it is a mere supposition that the barber-surgeon was the better informed of the two.

It would be possible to point to a number of inaccuracies (John Ray's views on fossils are misrepresented on p. 319, perhaps because the author had not consulted Dr. O. E. Raven's authoritative study of Ray) which are inevitable in a work of this scope, even though it can no longer claim to be pioneering. One might ask more seriously: For whom is this book intended? It is not a monograph for the professional historian, nor is it really suitable for the general reader. If it is intended for the cultural education of scientists, it is open to the charge of taking a narrow, and perhaps not very subtle, view of the origins of their studies. May one mildly express the hope that the time has now arrived when it is no longer necessary for every historian of science to take the whole of it for his province?

A. R. HALL

Properties of Matter

By Dr. F. C. Champion and Dr. N. Davy. (Student's Physics, Vol. 3.) Second edition. Pp. xiv+328. (London and Glasgow: Blackie and Son, Ltd., 1952.) 27s. 6d. net.

FOR schools of physics which teach properties of matter at third-year honours level, this work should make an admirable text-book. It covers the usual subjects, such as gravitation, elasticity, surface tension, osmotic pressure and viscosity, and, in addition, it has chapters on the compressibility of liquids and solids and on seismic waves, which give the student a clear idea of the practical importance of general principles. The various subjects are treated extremely competently, and the physical approach is not subjugated to the mathematical, as so often happens with advanced text-books.

To the reviewer, the only jarring note occurs on the last page of the book, in a chapter on errors of measurement; this chapter discusses the various theoretical considerations involved in assessing the probable error of a quantitative result, and illustrates them by the steps involved in the determination of ϵ and h . The result given for ϵ in 1932 is $(4.7787 \pm 0.0052) \times 10^{-10}$ e.s.u. The authors then state, without comment, that the value computed in 1941 was $(4.8025 \pm 0.0011) \times 10^{-10}$ e.s.u. Is this not likely to produce in the student a sense of scepticism about the whole of the theory of errors? Surely the authors should have taken the opportunity of stressing the importance of applying the theory only when systematic errors have been eliminated.

Mass Spectroscopy In Physics Research

Proceedings of the NBS Semioctennial Symposium on Mass Spectroscopy in Physics Research, held at the NBS on September 6, 7 and 8, 1951. (United States Department of Commerce: National Bureau of Standards, Circular 522.) Pp. vi+273. (Washington, D.C.: Government Printing Office, 1953.) 1.75 dollars.

THIS book is a record of the proceedings of a symposium on "Mass Spectroscopy in Physics Research", sponsored by the National Bureau of Standards and held in Washington, D.C., during September 6-8, 1951. The thirty-five papers submitted at the conference together with the discussion ensuing from each paper are given in full, and the book ends with a comprehensive account of an informal discussion on experimental methods. A good knowledge of existing mass-spectroscopy techniques is essential in order properly to appreciate the papers.

An excellent opening paper by J. Mattauch summarizes the field of high-resolution mass spectroscopy with application to the measurement of absolute masses. This is followed by a number of shorter papers by some of the leading physicists in the field of mass measurement describing instruments, the results obtained and possible improvements to the existing equipments. A number of instruments using new techniques for mass measurement are described, for example, time of flight and cyclotron resonance. Isotope abundance measurements are briefly summarized, and techniques are described for some specific problems on the variations in the abundances of naturally occurring isotopes. Two large-scale mass spectrometers are described which have been used successfully for separating very small quantities

of pure isotopes for nuclear physics research. The last group of papers deals with a number of specialized subjects which serve to illustrate the wide field of application of mass spectroscopy in modern physics research. In the concluding section, on experimental methods, the use of the electron multiplier as a detector of positive ions is discussed together with the current ideas on high-vacuum gasket materials, ion-source plate spacers, etc. The omission of any papers on the analysis of solid materials by the mass spectrometer is a criticism of the conference rather than of the book.

The book is a valuable acquisition for any laboratory interested in the problem of mass measurement, and it indicates the extensive part played by mass spectroscopy in physics and chemistry research.

G. H. PALMER

New Pathways to Piano Technique

A Study of the Relations between Mind and Body with Special Reference to Piano Playing. By Luigi Bonpensiere. Pp. xxiii+128. (New York: Philosophical Library, Inc., 1953.) 4.75 dollars.

THIS book has been posthumously compiled from notebooks left by Mr. Luigi Bonpensiere. In it is developed a theory of 'ideo-kinetics' based on the author's private experiments. These purport to show that with proper training we can achieve far greater control over our bodily movements and much more rapid acquisition of complex skills than is possible by means of our usual methods of 'physio-kinetics'. In 'ideo-kinetics' the limbs to be used (for example, the hands in piano-playing) are completely disregarded and instead the person concentrates intensely on the image of the goal to be reached.

Mr. Bonpensiere was first trained as a technologist; but his claim to distinction lies in his contribution to art and musicology. Unencumbered by academic lore, he later turned his original mind to empirical problems of body-mind relations and carried out experiments which, if confirmed, may lead to remarkable conclusions. The material is unfortunately fragmentary and expressed in a strange terminology, but the reader willing to overcome these obstacles will find much in it which deserves close study. Although Mr. Bonpensiere illustrates the applications of his theory from piano-playing, the theory applies to every form of bodily skill.

Mr. Aldous Huxley contributes a vivacious and sympathetic preface, and his description of the author as "remarkably gifted" seems to be perfectly just.

JOHN COHEN

The Year's Work In Librarianship

Edited by W. A. Mumford. Vol. 15, 1948; pp. x+281. Vol. 16, 1949; pp. x+230. (London: Library Association, 1952.) 40s. each vol.; to members, 30s.

THE annual publication "The Year's Work in Librarianship" consists of a series of chapters by different authors, those dealing with national and university libraries, with special libraries, with library co-operation, with professional education and with subject bibliography containing most of the information of interest to the man of science as such. They are comprehensive and competent pieces of workmanship, factual rather than critical, but of more worth to the librarian than to his clients. The time-lag in publication seems excessive for a publication of this kind: Vol. 15, covering 1948, appeared in the spring of 1952, and Vol. 16, for 1949, at the end of 1952.

BRITISH COLONIAL RESEARCH

REPORT FOR 1952-53

RESEARCH undertaken by government agencies in the British Colonies is described in annual reports under the general title of "Colonial Research". That for 1952-53* follows the pattern of the past two years. It commences with the report of the Colonial Research Council, which this year is slightly longer, and to which is appended a list of schemes approved for research grants, April 1, 1952-March 31, 1952, and the report of the Director of the Colonial Products Advisory Bureau for 1951-52. Following this are the reports of the specialist councils and committees: the tenth annual report of the Colonial Products Research Council, the ninth annual report of the Colonial Social Science Research Council, the eighth annual reports of the Colonial Medical Research Committee and the Committee for Colonial Agriculture, Animal Health and Forestry Research, the sixth annual reports of the Colonial Insecticides, Fungicides and Herbicides Committee and the Colonial Economic Research Committee, and the reports for 1952-53 of the Tsetse Fly and Trypanosomiasis Committee, of the Colonial Fisheries Advisory Committee on Fisheries Research and of the Director of the Anti-Locust Research Centre.

The fifty-six new research schemes and fifty-four supplementary schemes made during the year, involving grants totalling £1,087,041, brought the net expenditure and commitment from Colonial Development and Welfare funds since 1940 to about £11 millions at March 31, 1953, while Colonial Governments or industry have provided a further £3 millions. Of the gross allocation, 32.8 per cent has been for agricultural, animal health and forestry schemes, 14.2 per cent for medical research, 12.9 per cent for fisheries research, 10.6 per cent for tsetse and trypanosomiasis research, 9 per cent for social science and economic research, 7.5 per cent for insecticides research, 5.1 per cent for research sponsored by the Colonial Products Research Council and 3.4 per cent for anti-locust research. Under the assistance provided by the United States Mutual Security Agency, Prof. J. C. Matthysse, of Cornell University, completed his investigation in Northern Rhodesia into the control of the tick vectors of protozoal diseases affecting livestock in Africa, and Prof. M. Stelly, University of Georgia, is undertaking in Kenya an investigation into problems of soil fertility, while two United States scientists are to investigate in West and Central Africa pasture production and management and the nutritive qualities of species of grass and other local feeding stuffs.

During October 23, 1952-March 20, 1953, Mr. G. A. Atkinson, who is now housing adviser to the Colonial Office, as well as Colonial liaison officer, Building Research Station, made an extensive tour of East Africa, India and Malaya, as well as visiting Mauritius and attending an African regional housing research conference in Pretoria, organized by the Commission for Technical Co-operation in Africa

South of the Sahara. The discussions at this conference indicated that plans for the extension of building research in British West Africa, French African territories and the Belgian Congo are under way, and problems on which further co-operation is desirable were specified: these include the documentation of existing standards of housing, studies of the design of dwellings in relation to climate, a general study of rural housing problems, and studies on sanitation, and on building in earth and earth admixtures. Interest in the use in the tropics of prefabricated systems of house construction, exported from the United Kingdom, has been stimulated by a display of designs at the Housing Centre, London, and, afterwards, by the exhibition of demonstration houses at the British Industries Fair, 1953, while earlier investigations of the Building Research Station for the Uganda Government on raw materials for cement manufacture promise to initiate a series of industries in Uganda which may transform the economy of the Protectorate.

Recruitment of field-staff for geodetic and topographic surveys failed to keep pace with resignations or transfers; but prospects for recruitment of field-surveyors and other technical staff are now much better and an increase of more than fifty in the total staff during 1953-54 is anticipated. The priority area for photo control has been the Volta River area, where a survey by a party of six Directorate surveyors and an average of twelve Gold Coast African surveyors is approaching completion. A party which has completed control in the Western Concession in Northern Rhodesia is proceeding to control mapping for the Kafue Gorge hydroelectric scheme. Changing priorities and the impact of National Service on the cartographic staff have adversely affected map production. With the appointment of seventeen additional geologists and chemists, the overseas scientific staff of the Colonial Geological Surveys numbered 180 on December 31, 1952, and each year shows an increase in effectiveness as the young officers appointed during the past five years grow in experience and confidence. In Northern Rhodesia a new carbonatite occurrence was being examined, and detailed geological mapping was in progress in parts of the Mumbwa district, where copper-gold mineralization is known. In Nigeria several million tons of easily worked coal have been located near the colliery at Enugu, and much geological work has been carried on in other coal areas. Geological mapping has been resumed in some States of the Federation of Malaya, while interest in the mineral deposits of Jamaica has been aroused by the investigations of its Geological Survey Department. Appreciation is again expressed of the practical interest of British universities in the geology and mineral resources of the Colonial territories.

In Singapore some investigations by means of electro-osmosis have been made into the drainage of Singapore Harbour; in addition, the cathodic protection of mild-steel harbour craft by the use of zinc and aluminium anodes, and the use of the North Dakota cone penetrometer in evaluating the stability of road beds and determining economical thickness of road material for a given density of traffic have also been subjects of study. The general shortage of

* Colonial Office. Colonial Research 1952-1953. Reports of the Colonial Research Council, Colonial Products Research Council, Colonial Social Science Research Council, Colonial Medical Research Committee, Committee for Colonial Agriculture, Animal Health and Forestry Research, Colonial Insecticides Committee, Colonial Economic Research Committee, Tsetse Fly and Trypanosomiasis Research Committee, Colonial Fisheries Advisory Committee, Director, Anti-Locust Research Centre. Pp. 268. (Cmd. 8971.) (London: H.M.S.O., 1953.) 7s. 6d. net.

qualified meteorologists has hindered the filling of staff vacancies, particularly in West Africa and the British Caribbean area, but the Hong Kong Royal Observatory has published papers on the upper flow structure near typhoons and the general circulation of the atmosphere over South-East Asia and the Western Pacific and an analysis of forecasting of the summer weather of the region, besides continuing investigations into the effect of strong winds on rain-gauge accuracy and ionosphere-weather relationship. Seven bases of the Falkland Islands Dependencees Survey were manned throughout the year, while at Signey Island in the South Orkneys the reproductive cycle of the Weddell seal was studied.

All the work of the National Institute of Oceanography, except the care and superintendence of the Discovery Collections, is now centred in its new building at Witley, near Godalming. A main object of its laboratory work is to improve our understanding of marine physics and of the environmental conditions and biological factors which determine the concentrations and fluctuations observed in oceanic fisheries. The marine physiologists have concentrated on the problems of sea-air energy exchange and its relation to the large- and small-scale water movements, while much of the effort in marine biology bears on the problems of the life-history, distribution and migration of whales. Studies of the factors which make some parts of the deep ocean more productive than others have centred around recent and earlier surveys of the regions influenced by the Benguela and Peru currents. Work on Colonial problems at the Road Research Laboratory has been limited by shortage of staff; but a report has been issued on the stabilization of a black cotton soil from Southern Rhodesia with lime and wood tar, and recommendations have been made for the use in concrete of four sands and aggregates from North Borneo.

The Colonial Products Advisory Bureau completed seventy-seven laboratory investigations and dealt with 763 inquiries. The more important of these mentioned in the Director's report for 1952-53 are: the collaborative investigations on the biological activity of extracts and the storage performance of flowers of three strains of Kenya pyrethrum, which have indicated that one strain having a high pyrethrin content loses about 25 per cent of its original active content during three months of storage; the preliminary examination of essential oils obtained by steam distillation of sage leaves collected from thirteen localities in Cyprus during April and June-September 1951; the examination of samples of *Cinnamomum parthenocaryon* oil from Sarawak as a source of safrole, required for the synthesis of piperonyl butoxide; the examination as paper-making materials of timbers from twenty-eight species of trees, from Kenya, Malaya and the Gold Coast; and the trials in the Sudan on the drying of goat and sheepskins, which have shown that suspension drying in the sun, without salting, is more satisfactory than dry-salting, subject to a limiting temperature. Further examination of jute and possible jute substitutes has confirmed that, for the finer counts of yarn, jute is in a class on its own, but with further experience it is probable that retting could be carried out satisfactorily in Colonial countries. The work on the identification of fibres has already proved its value, and continued attention was given to a survey of Colonial materials which might be developed as sources of tannin. Work

on groundnuts was extended and advice given on breeding and analytical problems of the oil palm.

The tenth annual report of the Colonial Products Research Council records the completion of the clinical trials of the fungistatic antibiotic, comirin, whereby application of comirin was effective in twelve cases of otomycosis in which the isolated organisms were an *Aspergillus* species or the yeast *Candida parapsilosis*, and promising results were also obtained in the treatment of various forms of tinea. Most of the cultures added during the year to the Hankey Culture Collection (which now comprises 547 strains) were dermatophytes isolated in the work on comirin. Prof. C. H. Hassall and his collaborators have improved the methods of isolating and purifying the antibiotic monomyoin, and progress is also reported in the separation and characterization of the active materials in the monomyoin complex. In the Sugar Technological Laboratory at the Imperial College of Agriculture, Trinidad, pilot-plant trials have indicated that superstats had no significant effect on scale formation. Methods for the production of sugar-cane wax were improved, and the hard waxes obtained by the new process from filter-press muds should compete with carnauba in the preparation of high-grade polishes. Results obtained in the production of lactic acid and its esters from molasses were sufficiently promising to justify installation of a pilot plant, and a 10 per cent yield of itaconic acid has been obtained on the sugar by culture of an *Aspergillus*, using the techniques adopted in penicillin manufacture.

The technique for the bulk preparation of the crude *Striga* germination factor has been improved and the method of testing stimulatory solutions modified. In work on carbohydrates, Prof. M. Stacey and his collaborators at the University of Birmingham have confirmed by chemical methods that the polysaccharide produced by the enzyme derived from *Acetobacter caprolatum* is a true dextran and have determined the structure of the dextran produced by a strain of *Betaoococcus arabinosacensis*; in addition, they have initiated fundamental studies on the enzymes responsible for the synthesis of the main chains of α -1:6-linked glucopyranose units and the branch points involving the α -1:3 linkages. Prof. A. C. Frazer and his colleagues at the University of Birmingham have shown that histamine release by dextrans is dependent upon concentration and size; and in Prof. S. Peat's laboratory in the University College of North Wales, Bangor, further evidence was obtained of the unbranched character of the maltosaccharides from amylose by their reduction to the corresponding alcohols with sodium borohydride; and from this reduction technique a new micro-method was developed for determining the molecular weights of maltosaccharides. Partial hydrolysis of the 'insoluble' laminarin of *L. cloustoni* yielded the three disaccharides, laminaribiose, gentiobiose and β -trehalose, and five trisaccharides, containing permutations of the β : β -, β :3- and β :6-links to be expected from the nature of the disaccharides.

The component glycerides of coconut and palm-kernel oils have been shown to consist of complex mixtures of mixed glycerides. Conophor oil, from *Tetracarpidium conophorum*, gave highly satisfactory results in technical trials, and Prof. H. D. Kay found that the cake remaining after the oil extraction was palatable to most cows and may form a good protein concentrate.

The ninth annual report of the Colonial Social Science Research Council records little change in the

recruitment position: difficulties in obtaining senior staff and for demography and legal sociology continued. No Colonial research fellowships in the social sciences were awarded during the year; but the Council has set aside £10,000 for junior fellowships, attached to Colonial universities and university colleges during 1953-56, and the Goldsmiths' Company is awarding two scholarships tenable at African university colleges in 1953. The five American social anthropologists appointed under the special scheme for training American scientists at British universities have now all returned from the field, and Dr. E. W. Winter's report on the Basamba is in its final stages. The first of a series of official visits to the regional institutes of social and economic research to consider probable requirements after March 31, 1956, was made to the West Indies Institute of Social and Economic Research at the end of March 1953. Detailed reports of the work of the regional institutes are appended to the Council's report. A Social Research Unit has been set up by the University of Malaya and was to start work in 1953. The report includes a survey of research in the Colonial territories financed independently of Colonial Development and Welfare Funds and notes particularly the work of the East African Statistical Department on the best methods of estimating population growth in under-developed territories; the inquiry into the political institutions of the districts in Tanganyika; and the inquiry of the Education Department of Northern Rhodesia into relative standards of children born in North Rhodesia and elsewhere, the effect of a different mother tongue, of health, occupation of parents, etc., on education and progress of European scholars. The Education Department of the University of Malaya completed its word-frequency count of written Malay.

Seven sections of the Ethnographic Survey of Africa were published during 1952-53, and eight other sections were in the press. Part 2 of the General Survey in the "Handbook of African Languages"—"The Languages of West Africa"—was published, and Part 3, "The Languages of East Africa", was being prepared for the press. Mr. Arnold Epstein's report on his legal studies in North Rhodesia was published under the title "The Administration of Justice and the Urban African". Work is well advanced on the programme of anthropological studies in Sarawak, and the West Indian volume of the Demographic Survey of the British Colonial Empire was expected to be published. A list of publications during the year by workers assisted from Colonial Development and Welfare Funds is appended to the Council's report.

Of the twenty-one research schemes under the scientific supervision of the Colonial Medical Research Committee at the beginning of the year, that for the study of malaria in North Borneo and Sarawak has been concluded, and that for the study of leprosy in Malaya is in abeyance. The Committee's eighth annual report records the filling of five vacancies, and the facilities of the overseas research units have been much used by specialist workers from the United Kingdom for the short-term study of specific problems. In West Africa steps are being taken to transform the Standing Advisory Committee into an appropriately enlarged West African Council for Medical Research, which will have under its supervision the Virus Research Institute at Yaba (to be renamed the West African Council for Medical Research Laboratories), the Hot Climate Physiology

Research Unit at Oshodi, the Leprosy Research Unit at Uruakoli, and the Loiasis Research Unit at Kumba, and will develop further research on malaria, yaws and tuberculosis. The East African Medical Survey, now a compact and active group, with ample housing and laboratory facilities, has been concerned essentially with fact-finding in the field of public health. Continued work at Kumba in the Cameroons on the breeding of larvae, and on the flies of the forest canopy, brought to light two new species of *Chrysops*, three species not previously known in West Africa, and three previously known only as the prey of wasps in the Congo. *Culicoides austeni* has been shown to be a vector of *A. persians* in the area, and surveys of infections with *Loa loa* and *A. persians* in the human populations in the rain forests, the forest fringe and the mountain grasslands of the British Cameroons have shown that both parasites reach an equilibrium of high incidence and intensity in small villages in the rain forest, the incidence and intensity falling very rapidly in the areas of derived savanna and forest relict, while neither infection is transmitted in the grassland. Investigation of the chemoprophylaxis and chemotherapy of filarial infections continued at the Liverpool School of Tropical Medicine.

A survey of the incidence and distribution of filariasis in the Southern Highlands of Tanganyika was made in September and October 1952, and additional investigations of filariasis are reported from the Institute for Medical Research, Malaya, where the risk of introducing the Pacific (non-periodic) variety of *Wuchereria bancrofti* through the arrival of Fijian troops has been lessened by screening contingents destined for Malaya and by treating microfilaria carriers with 'Hetrazan' before arrival: the Institute is co-operating in periodic examinations of the whole battalion. Malaria research in North Borneo, Sarawak and Brunei was terminated in 1952 after providing a method of eradication, by clearing scrub and admitting sunlight, which at the same time encourages the economic development of the land and the prosperity of the people. The work has also provided a basis for future malaria work in Borneo, and the observations suggest a method of control which may be applicable elsewhere in the East in jungle areas where *A. leucosphyrus* may be the vector. The work of the East African Malaria Unit was concerned mainly with the daytime distribution of the resting-sites of *A. gambiae* and *A. funestus* in houses and outside, and with the relation of the blood-meal to ovarian development. Studies in Trinidad on the effect of residual insecticide spraying in three mud-huts fitted with exit traps of the Muirhead-Thomson pattern indicated that an aqueous suspension of DDT was effective up to five months and 'Gammexane' only up to less than two months, although, when fresh, 'Gammexane' had a repellency effect to entrance. On the Gold Coast the human reservoir of malaria infection in villages in a hyperendemic area was investigated from headquarters in Accra. A full report on trials of chloroquine, amodiaquin and pyrimethamine in Malaya is in preparation, and further tests of residual insecticides in window-trap huts have also been made on Malayan mosquitoes.

The East African Virus Research Institute, Entebbe, Uganda, where expansion on the clinical side is desirable, has concentrated its field-work on yellow fever in the drier country, where bush-babies (*Galago* spp.) and not monkeys appear to be the main

animal hosts of the virus. Some survey work on the Rift Valley fever virus was carried out and a strain of the Coxsackie virus was isolated from a member of the Institute's staff. In the work of the Scrub-Typhus Research Unit based on the Institute for Medical Research, Malaya, the emphasis was shifting to other infections which involve animal reservoirs, and the revised objective of the Unit is a continued study of animal ecology with special reference to medical problems. The work of the United States Army Medical Research Unit (Malaya), of which a summary is again given, has included studies of the resistance to penicillin and carbomycin of staphylococci from North Borneo, Malaya and the United States; investigations on Trombiculid mites were to be resumed in 1953. Surveys were made of relapsing fever in the Usambara Mountains, Tanganyika, and in the Teita Hills and Kwale district in Kenya. At the Lister Institute of Preventive Medicine a special study was made of the sera of the African species of the family Bovidae, and a completely new technique for identifying blood-meals of closely related species was being investigated, while the studies continued of serum proteins, of nitrogen balance and water content, and of hematology.

The Hot Climate Physiology Research Unit at Oshodi, Nigeria, completed a survey of the energy cost of most of the everyday tasks of the farmer, and started one of purely industrial tasks, particularly the energy cost of head-carrying. At the Uzuakoli Leprosy Settlement, Nigeria, pharmaceutical and therapeutic studies of sulphones have confirmed that small oral doses of 'Dapsone' are an effective, simple, safe and widely practicable form of chemotherapy of leprosy, and the good results previously recorded with *p*-acetamidobenzaldehyde thiosemicarbazone have been confirmed. In Nigeria the findings of the previous goitre survey were confirmed; the areas of obvious goitre lie on granite or are associated with granite outcrops in marine sediments or with drainage areas off granites, and such areas have been mapped in consultation with the Nigerian Geological Survey. The Field Research Station, Fajara, Gambia, continued its investigations into nutritional disorders, including the study of methods of determining the amino-acid content of tropical foods, and the scope of the work was extended to include studies on filariasis and schistosomiasis (particularly the treatment of elephantiasis of the leg) and the mosquitoes which may transmit *W. bancrofti* in the Gambia. Some notes are included on the medical work undertaken and financed by the Medical Departments of Colonial Territories—for example, the treatment of malaria with daraprim in Kenya, clinical trials of 'Sulphetrone', 'Dapsone', 'Thioacetazone', 'Ethionine', 'Isoniazid' and 2-anilino-3-amino-5-phenylphenazide hydrochloride at the Leprosy Hospital, Makogai, Fiji, and a study of 'vomiting sickness' in Jamaica.

Grants totalling £372,286 were made during the year for new and existing schemes from Colonial Development and Welfare Funds by the Committee for Colonial Agricultural, Animal Health and Forestry Research, the annual report of which again acknowledges particularly the assistance of the Commonwealth Institutes of Entomology and of Biological Control and of the Commonwealth Mycological Institute. Progress in some sections of the East African Agriculture and Forestry Research Organization was retarded by the declaration of a State of Emergency in Kenya, but research in soil micro-

biology was started and a satisfactory technique for inoculation of maize for resistance to the American rust disease caused by *Puccinia polysora* Underw. was taking shape as a result of co-operative work with Amani as well as the Kenya and Uganda Departments. Co-operative work with the Cotton Research Station, Namulonge, has demonstrated the repellent effect of certain insecticides against the *Lygus* pest. Soil surveys at different category-levels were continued as well as laboratory work on the fertility of tropical soils. The major buildings and other facilities of the new headquarters of the East African Veterinary Research Organization at Muguga South were completed or well advanced by the end of the year under review, and earlier findings have been confirmed that treatment of bovine trypanosomiasis with 'Antrycide', while effective in the early stages, is much less so in advanced trypanosomiasis, and that prophylactic treatment of cattle in contact with tsetse fly should be given at least once every two months. The main factor determining the success of the drug in protecting cattle appears to be the severity of the challenge by trypanosomes, which in turn depends on the nature and number of the tsetse flies to which the cattle are exposed. Research was continued on the systematics and life-cycles of the paramphistomes of domestic ruminants.

At the West African Cacao Research Institute demonstration of the control of swollen shoot by regular inspection and cutting-out of symptom-bearing trees and replanting was continued, as well as investigations on the symptoms and classification of cacao virus strains from the Gold Coast, Nigeria and the Ivory Coast, and on the mealybug vectors of these strains; and the search went on at the West African Rice Research Station, Rokupr, Sierra Leone, for maize varieties which combine high yield and resistance to attack from the rust disease pathogen *Puccinia polysora*. At the British West Indies Central Sugar-Cane Breeding Station, Barbados, further progress was made in the pure-line breeding programme, and a satisfactory cytological technique, involving pre-treatment of root-tips in α -bromonaphthalene solution to condense and spread metaphase chromosomes, was evolved. Investigations at the Imperial College of Tropical Agriculture, Trinidad, strengthen the opinion that the deterioration of cacao soils is due to loss of litter, crumb, and highly organic topsoil through erosion, wastage by oxidation of organic matter and nutrient exhaustion. The ecological land-use survey of British Honduras commenced in August, and the preliminary ground survey of the Northern, Corozal District was virtually complete by the end of the year under review. Among researches undertaken by the Colonial departments may be mentioned one in Barbados on the control of cane-root-destroying pests, such as *Diaprepes abbreviatus*, *Olethreus ornithi*, and *Aceropyga* ants and wood ants in cane fields with the gamma isomer of benzene hexachloride diluted with milled coral limestone; in the Gold Coast on the control of maize-stem borers with DDT and benzene hexachloride preparations; on the improvement of biological control of coffee-mealybug (*Planococcus kenyae*) in Kenya by introducing and establishing further species of natural enemies from Uganda; studies on the control of black pod disease of cocoa (caused by *Phytophthora palmivora*) in Nigeria; the studies of control of tick-infestation of cattle in Northern Rhodesia, which indicate the wide field of application in Africa for the portable power-spray; and of the *Theraptus*

damage to coconuts in Zanzibar, where an experimental double aerial spraying with DDT in oil formulation was given to five hundred acres of coconut plantation.

The sixth annual report of the Colonial Insecticides, Fungicides and Herbicides Committee includes an account of the work of the Colonial Insecticide Research Unit at Porton, where studies continued on the sorption of insecticides by certain types of dried mud used for native houses in many parts of the tropics in an attempt to explain the relatively poor effect of DDT against certain species of mosquito (notably *Anopheles gambiae*), and a preliminary wind tunnel study was made of the deposition of small particles on various obstacles, including tsetse flies, at low wind speeds. Air-borne drops appeared to be deposited more readily on tsetse flies at rest on the obstacles than on the obstacles themselves, and for such deposition the optimum drop-size range with the cylinders and disks used at wind speeds of up to 4 m.p.h. is 10-30 μ , although since drops in this size-range are not collected efficiently by the cylinders and disks, larger drops are required for deposition on them. A team from the Unit continued the aircraft-spraying trials against tsetse flies in field experiments at Urambo in the western Tanganyika *morsitans* belt and at Maruzi in Uganda in thicket typical of much tsetse brush in East Africa, and very promising results were obtained by aircraft spraying five hundred acres of coconuts infested with a coreid bug (*Therapsus* sp.) at Zanzibar using a 9.2 per cent solution of DDT in oil as well as in spraying with a DDT emulsion five hundred acres of beans near Arusha, which were heavily infested with larvae of the American bollworm (*Heliothis armigera*).

The malaria eradication experiment in Mauritius was terminated: malaria transmission virtually ceased with the elimination of *A. fuscus*, and the reduction in houses of *A. gambiae*. A full report was in preparation of the experiment in malaria control in Malaya, now terminated, in which promising results were obtained with both DDT and benzene hexachloride. Very promising results were obtained in defoliation experiments with bush infested with *G. palpalis* and *G. pallidipes* in Kavirondo, Kenya; but in the experiments with the *n*-butyl esters of 4-chloro-2-methylphenoxyacetic acid, 2:4-dichlorophenoxyacetic acid and 2:4:5-trichlorophenoxyacetic acid, overall spraying of regenerating savanna-thorn bush at Shinyanga, East Africa, and regenerating *Isobertinus* woodland at Kikare when the regenerating shoots were 2-4 years old over a two-year period failed to eradicate the bulk of the species.

At the Imperial College Field Station, Silwood Park, transport of DDT solutions in lanoline across the integument of blowflies was investigated and studies of the contamination of flies exposed to particulate deposits continued. At Rothamsted Experimental Station the rate of loss of insecticidal effect of DDT deposits on living foliage in the glass-house was studied under various conditions. In Uganda investigations on the control of blackarm disease of cotton were completed, while in Malaya control of insect pests troublesome in the field establishment of young cacao were controlled by soil treatment with benzene hexachloride and dusting the plant with DDT wettable powder.

The Colonial Economic Research Committee still finds it difficult to recruit qualified candidates, but the decision to invite universities and university

colleges to propose schemes for economic research has had good results. The Committee's sixth annual report records that Dr. J. Greaves's monograph on "Colonial Monetary Systems" was in the press, as was Dr. A. R. Prest and Mr. I. G. Stewart's report on "Nigerian National Income, 1950-51". The Committee has approved three grants: for Dr. F. C. Wright's study of the structure and organization of the distribution in Tanganyika and Nyasaland; towards half the recurrent expenditure of an Economic Research Unit at the University College of the Gold Coast until March 31, 1956; and for a scheme to promote the study at the University College of the West Indies of the methodology of capital formation, with special reference to capital investment in Jamaica.

The report of the Tsetse Fly and Trypanosomiasis Committee for 1952-53 records further advances in the integration of tsetse research and of research on human and animal trypanosomiasis in East Africa. Satisfactory results have been obtained in experimental reclamation projects, and pilot schemes of practical reclamation in conjunction with the utilization of land have been started in the three mainland territories. The Antryoids Research Scheme was terminated at the end of March 1952, but investigations were being continued under the Trypanosomiasis Research Laboratory. The West African Institute for Trypanosomiasis Research also reports satisfactory progress. Reports on the use of 'Antryoids' methyl sulphate for curative purposes continued to be generally favourable. Special attention was given to the study of *T. vivax*, including work on its transmission by *G. palpalis*.

The annual report on Fisheries Research of the Colonial Fisheries Advisory Committee records that the number of fishery officers was stabilized at about fifty-four, and recruitment and training were largely concerned with replacements. Commitments for new schemes and for the extension of existing ones until March 31, 1956, are estimated at £85,510, with an uncommitted balance of £68,800. At the Inter-territorial Fisheries Research Station at Jinja a new technique to determine chemical deficiencies in lake waters has been developed, using algal cultures as indicators, and results have shown that sulphates may sometimes be the primary deficiency. Considerable advances have been made in studies on the taxonomy of the fishes *Haplochromis* and *Tilapia*. At the Inter-territorial Marine Fisheries Research Station at Zanzibar the emphasis has been on the distribution of the big surface fishes, while continued experiments at the West African Fisheries Research Institute on the control of marine wood-borers by concussion have shown that, while detonation by small explosive charges greatly decreases the incidence of the common shipworm *Teredo*, it is ineffective against the *Martesia* wood-borer. No progress is reported at the Research Station for Fish Culture in Malaya.

The report on Locust Research and Control, 1952-53, covers the work of the Anti-Locust Research Centre, which received 1,265 reports on the locust situation from forty-one countries and territories. Besides its studies of factors affecting the rate of sexual maturation in the desert locust, it carried out with the Desert Locust Survey investigations, on the Somali peninsula, on swarms of desert locusts during August-November 1952, which threw some light on the mechanism of displacements associated with the Inter-Tropical Convergence Zone. During the year

the desert locust situation, in contrast to that in the outbreak areas of the African migratory and the red locust, was extremely serious, particularly on the Somali peninsula and in Arabia. In the Somali Peninsula and the coastal areas of Saudi Arabia it was brought under control by the Desert Locust Control Organization of the East Africa High Commission, in co-operation with the Saudi Arabian and Ethiopian authorities and the Somali Administration.

LIMITS TO A FIRM'S CONTROL OF LABOUR TURNOVER

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LIKE all social and economic phenomena, labour turnover is determined by the interaction of numerous factors involving both economic and non-economic motives. While all these factors operate simultaneously, some of them exert a much stronger influence on the level of turnover than others. The ability of a firm to limit its labour wastage will depend on the strength of the influence on turnover of factors which it can control or modify; it cannot hope to alter a high turnover-rate if it is due to external factors, outside its control.

Opinions differ about the weight which must be attached to external and internal factors as determinants of labour turnover. Some writers, such as Florence¹, Long² and James³, emphasize the importance of external factors while acknowledging that the firm has a part to play. Other writers, for example, Cook⁴ and Greystoke⁵, stress the significance of the individual firm. The Tavistock Institute team, Rice, Hill and Trist⁶, take up an extreme position and assert that labour turnover is a "function of an industrial organisation as a social institution", and this view, which is not backed by valid evidence, appears to have gained considerable ground in recent years. (For an examination of the validity of evidence, compare Behrend⁷.) My own research points to a different hypothesis.

The problem is one of finding objective criteria to assess the relative influence of external and internal factors on labour turnover. In developing a technique the following considerations are of importance. While labour turnover must be regarded as a function of both external and internal factors, it is conceivable that the difference between two labour turnover-rates can be traced back to only one group of these variables. As external factors operate in the whole community, their influence, if it exists, must be noticeable in many firms and not restricted to one firm. Therefore, if we discover evidence that there exist certain types of differences in turnover which are found in the majority of factories, external factors can be assumed to be at work. On the other hand, the effect of internal factors must be restricted to one particular plant. Thus, if we find an isolated instance of an observed significant difference in turnover, internal factors can be assumed to be at work.

The extent of the incidence of differential turnover-rates or of changes in labour turnover thus provides

a criterion for assessing the influence of external as opposed to internal factors on labour turnover.

This criterion can be applied to the findings of labour turnover research which has revealed that the following five types of differences in labour turnover at the same point of time exist among workers in manufacturing plants (cf. refs. 1-5 and others).

(1) Labour turnover differs for the sexes. In practically all factories in England it is higher for women than for men in the same age and length of service group. It must be stressed, however, that this is linked with type of work (cf. ref. 4).

(2) Labour turnover varies for different age-groups. It tends to decrease with age, at least after the age of thirty, and this fall appears to be fairly universal.

(3) Labour turnover differs for workers with different lengths of service. It is well known that in all factories turnover is highest among newcomers and lowest among long-service workers.

(4) Labour turnover differs with type of work. It tends, for example, to be lower for skilled workers than for unskilled ones. Contrary to expectation, there appears to be no evidence that these variations are linked to differentials in wage-rates or earnings.

(5) Labour turnover varies with the number of jobs in the local labour market. In a large town with many factories wastage-rates tend to be higher than in an isolated area where one factory is the main employer.

Labour turnover thus differs with sex, age, length of service, occupation and employment opportunities. These five types of variations have been found to be general phenomena, observable in the majority of factories, and must thus be attributed to the operation of general external factors.

It follows from these findings that comparisons of the level of turnover of different factories and departments at the same point of time, with the view of isolating the effect of the firm on labour turnover, should be based on standardized rates, namely, on age-specific turnover-rates for men and for women in given occupations belonging to specific length-of-service categories and living in similar labour markets. So far as I know, the construction of such rates for inter-factory comparisons has never been attempted.

Fortunately, standardization of turnover-rates is mainly essential when comparing different factories or departments at the same point of time; it does not appear so necessary when one is comparing figures for the same factories or departments for successive periods of time provided they have fairly stable population structures. (The comparison would be based on the simplifying assumption that the characteristics of the population do not change significantly from one year of observation to the next and must be restricted to factories with stable population numbers.)

When studying successive periods of time, external factors can be deemed to be at work if certain changes in labour turnover occur in the majority of factories, while internal factors can be assumed to be operating if the observed change is an isolated event restricted to one firm, factory or department, not experienced by a control group of factories, or deviating from the trend of the control group.

A considerable amount of evidence is available to show that changes in external factors lead to widespread and marked changes in the level of labour turnover. Data published by Florence¹, Long², Woytinsky⁸ and myself⁷ show that changes in the level of turnover correspond to changes in the level

of employment. Under full employment labour turnover tends to be high, and it falls with rising unemployment. As small an increase in the unemployment-rate as a rise of 0.4 percentage points was found to have led to a very marked reduction in the level of labour turnover².

The course of the Second World War can also be shown to have affected the level of labour turnover³.

What is the effect of changes in internal factors? Firms claim that introduction of the incentives and bonus schemes, of personnel management, of induction and training schemes, and of better management and supervision will each lead to a fall in labour turnover. Yet it is extremely difficult to find valid evidence to prove this. Most of the claims of success are not substantiated by data for control groups. In published literature and in data collected by myself, I have been unable to discover more than four cases of the effective reduction of labour turnover in experimental plants, where the control groups showed no corresponding change.

Florence⁴ quotes a study made by the U.S. Department of Labour in 1920 which shows that the introduction of "definite labour policies and centralized employment machinery" in a number of 'experimental' establishments was followed by a reduction in the wastage-rate from well above that of the control group to less than half that of the control group. Long⁵ gives an example where a change in the management and organization of a factory together with the introduction of time and motion study led to a proportionately greater fall in the male labour turnover-rate of the experimental plant than the ordinary post-war reduction shown by two other factories owned by the same firm. In a department of Company J, I found that a change in supervision together with a complete re-organization of the department, including the introduction of time and motion study, was followed by a remarkable drop in labour turnover, while the other departments of Company J showed no corresponding change. In Company P, labour turnover was reduced significantly from one year to the next, while other factories in the same area showed no comparable reduction. This was attributed to the combined effect of "important changes in management attitude, in pay, in conditions, in benefit plans, in the efficiency of supervision, and in other aspects".

It can be seen that these four cases all entailed a series of simultaneous and extensive changes in organization. But if really radical changes in organization take place, they probably involve changes in factors which were shown earlier to be external factors, for example, in type of work. This would be true of three of the four cases. Furthermore, such changes would normally be followed by changes in the work-force, for better work methods mean more output, and population numbers are adjusted to the output target. Other external factors such as the composition of the work force and employment opportunities are thus likely to alter.

On the whole it appears to me that all the available evidence suggests that quite small changes in external factors, namely, in the level of employment, produce far more pronounced changes in the level of labour turnover than small changes in internal factors. Only extremely radical changes in internal factors can achieve similar results; but if such extensive changes take place, they probably involve changes in external factors.

One can go one step further and say that external factors, particularly the level of employment, are the decisive factors in this field which determine not only the behaviour of individuals but also the action of firms. When the level of employment changes, the labour problems of a firm alter and this affects management's policy with regard to all aspects of labour management. Changes in external factors thus give rise to changes in internal factors. Internal factors are not independent variables, but are largely an adjustment to general factors as they affect the firm or an attempt to modify them. Under full employment, for example, the firm's response to the shortage of labour is to 'woo' workers to stay with it by the introduction of elaborate employee services of all kinds. Theoretically it would appear highly plausible that these measures are effective and reduce the high level of labour turnover. In practice, however, there is very little evidence to support the claim that labour turnover can be modified by organizational action—short of changes in the whole set-up. This appears to be so even though we know when and where action is necessary. It is needed in times of full employment, and it must concentrate on modifying the influence of age, length of service and type of work, by trying to create a sense of loyalty and 'belonging' in the newcomer and in the young worker, and by studying the type of work to see whether irritating elements of the job can be eliminated and 'traction' increased. (Traction is 'the feeling of being pulled or drawn along by the inertia inherent in a particular activity'; compare Baldamus¹⁰.)

It may be objected that I have ignored the most important incentive the firm can offer, namely, wage-differentials, and that the payment of relatively higher wages than neighbouring plants is likely to be an effective tool of control at the disposal of the firm.

Labour turnover research, however, has provided no evidence so far to show that relatively higher wages stabilize a firm's work-force. This may be partly because the effect is difficult to isolate and partly because few firms pay high enough wage-differentials. A firm's ability to pay higher wages than its neighbours is limited by external factors, such as economic market forces which determine the receipts for its sales. Managers frequently express the belief that they cannot afford to pay higher wages because increased labour costs reduce profitability and they feel this more than offsets any gain in labour stability. They thus do not seem to consider the use of higher wages as a tool of labour control to be a workable proposition. (The introduction of wage-differentials which aim at paying relatively higher wages than other factories means that a firm pays a higher wage for a given output than previously. This must not be confused with the use of incentive payment schemes where increased pay is linked to increased output and therefore does not increase costs.)

It appears that the firm's control over labour turnover is very limited, and that labour turnover is mainly determined by factors outside the firm's control, modifiable only to a small degree. The problem so frequently discussed in economics of the different effectiveness of the 'stick' and the 'carrot' applies. Unemployment as the stick appears effective as a limiting factor to labour turnover, but we do not yet know how to make organizational policy act as an effective carrot, although firms have been

searching for such an incentive ever since the pressure from unemployment has been relaxed.

- ¹ Florence, P. Sargent, "Economics of Fatigue and Unrest" (London: Allen and Unwin, 1934).
- ² Long, J. R., "Labour Turnover under Full Employment", Monograph A2, University of Birmingham, Studies in Economics and Society, 1951.
- ³ James, R., *Econ. J.*, 59, No. 233 (1949).
- ⁴ Cook, P. H., *J. Inst. Personnel Management*, 23, 2 (1951).
- ⁵ Greytokes, J. R., Thomason, C. F., and Murphy, T. J., *J. Inst. Personnel Management*, 24, 153 (1952).
- ⁶ Rice, A. K., Hill, J. M. M., and Trist, E. L., *Human Relations*, 3, No. 4 (1950).
- ⁷ Behrend, H., *J. Indust. Econ.*, 2, No. 1 (1953).
- ⁸ Woytinsky, W. S., "Three Aspects of Labour Dynamics" (Washington: Social Science Research Council, 1943).
- ⁹ Behrend, H., *Occupational Psychol.*, 27, No. 2 (1953).
- ¹⁰ Baldamus, W., *Brit. J. Sociol.*, 2, No. 1 (1951).

TOTAL SOLAR ECLIPSE OF JUNE 30, 1954

A TOTAL eclipse of the sun will occur on June 30, 1954, the belt of totality stretching from near Minneapolis, where eclipse comes at sunrise, through north-eastern Canada and Greenland, across the Faroes, Norway, Sweden, the Baltic and south Russia, finally ending at sunset not far from Peshawar. Many European astronomers are proposing to go to southern Sweden to make observations, since this is an easily accessible portion of the eclipse track and the chances of a clear sky are reasonably good (about 50 per cent). Mid-eclipse comes near noon in the Faroes and in the early afternoon in Scandinavia. The belt of totality is about ninety miles wide, and near the centre line the duration of totality is 2½ minutes. The corona may be expected to be of the type associated with minimum sunspot activity. Preparations are known to be under way for parties of observers from Great Britain, Eire, France, Switzerland, Holland, West and East Germany, Italy and Canada. Swedish astronomers, who are naturally taking a very active interest, are organizing groups of observers to work at three or more separate places.

The Royal Greenwich Observatory is to send a small group to measure the gravitational deflection of light by the sun. This is a fairly favourable eclipse for this purpose, as the star field is a good one, although the duration of totality is not specially long. Another group from Greenwich will be engaged in measuring accurate positions of the cusps for geodetic purposes. The Cambridge Observatories are planning several types of observation: (1) measurement of chromospheric line profiles with a large spectrograph giving a dispersion of about 1 Å/mm.; (2) measurement of the electron temperature of the chromosphere by Zanstra's method; (3) observation of the corona in the light of the green line 5303 Å., using an interference filter and a Fabry-Perot interferometer of low resolving power, to examine the distribution of line width, and of line of sight motion. This last experiment is being carried out in co-operation with the St. Andrews Observatory. St. Andrews is also sharing a project with the Potsdam Observatory, to measure the deflection of light by the sun with an elaborate apparatus developed from that used by Potsdam observers some twenty-five years ago in Sumatra. The University of London Observatory is to carry out photographic photometry of the corona, with a new arrangement which should reduce trouble from scattered light and also should extend the range of surface brightness measurable.

The Dumank Observatory is to measure line-widths in the spectrum of the low chromosphere, using a Fabry-Perot interferometer.

All the foregoing parties will observe in various places in south Sweden. In addition, the Cambridge Observatories, with the help of the R.A.F., are photographing the outer corona in polarized light from an aircraft at about 30,000 ft. altitude, using a multi-lens camera designed for freedom from scattered light. Observers from the University of Edinburgh are also utilizing aircraft, in an attempt to detect a daylight aurora during totality. Both these flights will probably take place north of the Shetlands.

The plans of astronomers from other countries are not yet generally known; but a few details can be given here. French observers (MM. Dollfus and Michard) will use a spectrograph devised by the late Dr. B. Lyot, permitting photography of the coronal spectrum simultaneously around almost the whole sun. Dutch astronomers (Prof. M. G. J. Minnaert and Dr. J. Houtgast) will examine the Fraunhofer spectrum of the corona, and the distribution with respect to height of material in the chromosphere. Two Canadian parties intend to observe the chromospheric spectrum, one from the Dominion Astrophysical Observatory, Victoria, B.C., with a slitless instrument, the other from the Dominion Observatory, Ottawa, with a high-dispersion slit spectrograph.

OBITUARY

Dr. Karl B. McEachron

DR. KARL B. MCEACHRON, consultant to the General Electric Company at Pittsfield, New York, died in hospital on January 24, aged sixty-four years.

Dr. McEachron's name will always be associated with high-voltage research work and with the study of lightning. He was an instructor for some years in the Ohio Northern University and at Purdue, and in 1922 took charge of the research and development section of the Lightning Arrester Engineering Department of the Pittsfield factory of the General Electric Company. Here he developed techniques for producing and recording electrical transients of very short duration, and was one of the first engineers to apply surges from an impulse generator directly to overhead transmission lines in order to study the attenuation of high travelling-wave voltages and their effect on terminal apparatus. He was largely responsible for the successful production of the "Thyrite" lightning arrester, embodying material composed of carborundum and graphite having a fourth-power voltage/current characteristic. His published work on this development is to be found in the *Transactions of the American Institute of Electrical Engineers* in the years 1928-33, and for this he received the Charles A. Coffin Award of the Edison Electric Institute in 1931 and the Longstreth Medal of the Franklin Institute in 1936.

In 1933 Dr. McEachron was appointed engineer-in-charge of the High Voltage Engineering Laboratory at Pittsfield and there began the study of lightning flashes striking transmission lines and—later—striking to the top of the Empire State Building, New York. He installed oscillographs on the top floor connected to the radio antenna system of the National Broadcasting Company twelve hundred and fifty feet above street-level and placed a variety of types of Boys's cameras on the fifty-sixth floor of

500 Fifth Avenue, from which a good view of the top of the Empire State Building was obtained. Schonland had by this time established the existence of the downward directed 'leader' stroke to the lightning flash, but McEachron's paper to the Franklin Institute in 1939 showed that in fact nearly all lightning flashes to the Empire State Building begin by discharges extending in step-by-step formation from the top of the building to cloud. The oscillograms of the same lightning strokes disclosed that although the luminosity often falls to zero between the successive strokes of a lightning flash, the current through the oscillograph did not. There were long 'continuing strokes' lasting many milliseconds between the high luminosity large current strokes. McEachron showed that these continuing currents in fact carried larger charges to ground than the

charge associated with the bright main strokes, and it was suggested that these 'continuing strokes' might be responsible for many strange failures of lightning arresters and may explain the cause of fires initiated by lightning. For his outstanding work in gaining quantitative data on lightning discharges McEachron was awarded the Edison Medal of the American Institute of Electrical Engineers, being the thirty-ninth holder of that Medal.

He was one of the most-sought-after speakers in the General Electric Company and lectured extensively in the United States and Canada. He accumulated an immense collection of photographs of lightning, and gave visitors from overseas a most cordial welcome and a fascinating review of lightning studies. He leaves a widow, three sons and two daughters.

T. E. ALLIBONE

NEWS and VIEWS

The Ancestry of Sir Isaac Newton

At an ordinary meeting of the Scottish Genealogy Society, held in Edinburgh on February 16, the honorary secretary of the Society, Rolland J. B. Munro, read a paper entitled "Notes on the Ancestry of Sir Isaac Newton", in which he claimed that there is a strong possibility of Newton being of Scottish descent. Newton occupied himself very much with genealogy, there being evidence of his interest in this in 1659, at the age of seventeen; and after 1705 he made a painstaking search to uncover his ancestry, leading to a great mass of papers sold at the Ridd Sale in three portions, the smallest portion of which was bound in seventeen volumes. Mr. Munro's main argument was that it was Newton himself who, as a result of these investigations, claimed Scottish ancestry. Sir Isaac's grandfather, Robert Newton, undoubtedly bought the manor of Woolthorpe, and Mr. Munro maintains that Robert had left Scotland with the court of King James VI of Scotland, afterwards to become James I of England. Sir Adam Newton, Bart., of Charlton in Kent, the son of an Edinburgh baxter and burgess, a scholar of high repute and favourite of Andrew Melville, was tutor and secretary to Henry, Prince of Wales, the elder son of James, who died early. Sir Adam also had a brother Robert, and it is suggested that he became Robert Newton of Woolthorpe and lord of that manor; for, if he were an Englishman, his ancestry seems to be enigmatic. The Charlton Newtons are clearly a cadet of the Newtons of that ilk in East Lothian, from whom, so Sir Isaac is said to have stated, his grandfather claimed kinship and descent. Evidence was shown by Mr. Munro that the Lairds of Long Newton in East Lothian had suffered by adherence to the cause of Mary Queen of Scots, that one of them went to England, and that for these financial and material hardships they were rewarded by James VI. Robert and James Newton followed with Sir Adam, but were not so lucky as the latter, and each, it may be significant, eventually went to the University of Padua, where Galileo had taught the doctrines to which Sir Isaac added his intellectual seal. Attention was also directed by Mr. Munro to the fact that one of Newton's relatives owned Gordon Mill, near Kelso, during Sir Isaac's life-time, and that this cousin lived with him for a period.

Continued Employment of Older People

REPLYING in an adjournment debate on the employment of older men and women in the House of Commons on February 5, the Parliamentary Secretary to the Ministry of Labour and National Service, Mr. H. Watkinson, pointed out that the National Advisory Committee on the Employment of Older Men and Women is a standing committee which has only just started its work. The research sub-committee also set up meets frequently, and other sub-committees will be established if necessary. Mr. Watkinson urged that the whole problem should be examined in the light of two principles: capacity, not age, should be the first consideration in recruiting staff or engaging people, and all who can continue to give effective service in their occupation should have the opportunity of continuing, if they wish, irrespective of age. Mr. Watkinson referred particularly to the shortage of skilled engineering craftsmen and to the value of older craftsmen as a reservoir of skill, who could at least be employed for shorter hours or as instructors. With regard to the professional man and the obstacle which pension schemes present to continued employment, he said that the Association of Superannuation and of Pension Funds had authorized him to state that the Association could show any employer who felt that a pension fund or superannuation fund is a bar to the employment of older men and women how to modify that policy. After referring to the efforts of the Ministry to influence opinion and to spread the knowledge of what the Advisory Committee is doing, Mr. Watkinson appealed for the co-operation of employers, trade unionists, members of Parliament and all people of goodwill in solving a problem which is of vital importance to the national economy and to the health and happiness of older people themselves.

Nationalized Industries and Accountability

In opening a debate in the House of Commons on February 8, on the Report of the Select Committee on the Nationalized Industries, the Lord Privy Seal, Mr. H. Crookshank, said that in principle the Government accepts the idea of a select committee and also the recommendations of the present report on that subject, subject to modifications and to consideration of the views expressed in Parliament. The Government would prefer to keep open the

possibility of a joint select committee of both Houses. While the Government agrees entirely that the terms of reference of the proposed committee should not enter into questions of detailed administration, it does not agree with the proposal that the committee should inquire into future plans and programmes as suggested in the report. To commence with, the Government thinks that the committee should not exceed ten to fourteen members, and that it would be a mistake to provide the committee with a permanent officer of the House, such as the Comptroller and Auditor General. It prefers the alternative suggestion of beginning with a clerk from the committee office and with someone of the nature of a Treasury liaison officer. If an independent officer is then found to be required, the matter could be considered by Parliament. Tentatively, Mr. Crookshank suggested that it would be much wiser not to publish all the evidence but merely reports from time to time, and it is not thought that every industry should come, in some form or other, before the select committee each year. It should be made clear that the constitution of the committee should not touch in any way the existing rights of ministers under legislation.

Auditing of Non-Recurrent Grants to British Universities

In a Special Report from the Committee of Public Accounts (Session 1953-54: Treasury Minute and Abstract of Appropriation Accounts, 67. London: H.M.S.O., 1954; 1s. net) the Treasury refers to the recommendation of the Committee, in its third report for session 1952-53, that the books and accounts of the universities of Great Britain relating to their expenditure of non-recurrent grants should be open to inspection by the Comptroller and Auditor General. The Treasury reiterates that it has no reason for thinking that the sums voted have not been wisely administered. The essence of the relations between the universities and the Government has been that the Treasury should avoid any detailed control of the activities of universities. Neither the Treasury nor the University Grants Committee has ever claimed the right to examine the universities' books, and the Treasury believes that to do so in the way suggested by the Committee would lead to increased intervention and extended control in a way which would prejudice the present harmonious relation between the universities and the University Grants Committee. The Treasury, however, foresees no difficulty in making satisfactory arrangements with the universities which would enable the Public Accounts Committee to satisfy itself that the grants are duly appropriated to meet the expenditure for which they are made, though the precise part to be played by the universities' auditors and professional advisers will require consideration. With regard to the more important question of ensuring economy in the expenditure of non-recurrent grants, the Treasury is considering whether the assurances desired could be obtained by some other means; thus the University Grants Committee might appoint one or more persons to report to it on any changes necessary to ensure that the methods adopted by the universities for contracting and recording and controlling expenditure are reasonably designed, and properly applied, to provide effective safeguards against waste, extravagance or other abuse. Such a report would be made available to the Public Accounts Committee with a note of any action taken or proposed. The

Treasury proposes to discuss this matter with the university authorities.

Co-ordination of Research In Scotland

In reply to a question to the Secretary of State for Scotland, on February 2, referring to co-ordination between government, industrial and university laboratories for pooling the results of their scientific and technological research work, Mr. J. Stuart stated there is free exchange of research information between the universities, industrial research associations and the Department of Scientific and Industrial Research. That Department operates a technical information service available to large and small firms alike, and the research associations provide industrial liaison services to their member firms. The Department is arranging with the Scottish Office for a study of the special needs of small firms in Scotland for research and technical information.

Absenteeism of Workers In Small and Large Organizations

UNDER the title "Size and Morale: Preliminary Study of Attendance at Work in Large and Small Units" (pp. 44; London: Acton Society Trust, 1953; 3s. 6d.), the Acton Society Trust has issued a report covering three inquiries: one in the coal industry, one in a large industrial group and one in a large retail organization controlling 230 stores throughout Great Britain. All three inquiries showed that, as a general rule, workers are absent from work for one reason or another more frequently in large concerns than in small ones. The trend is particularly noticeable in the coal industry; it is fairly marked in the industrial sample, and just discernible in the commercial undertakings that were studied. The investigation showed that miners in the smaller pits appeared to take much more interest in the affairs of their own pit than did men working in larger pits. Further, absenteeism and accident-rates were statistically correlated with size throughout the coal industry, and, when similar geological conditions were being worked, output per man-shift tended to be higher in small pits than in large. It is not suggested that workers' morale is necessarily worse in large than in small units: the study emphasizes that there is an urgent need for detailed descriptive studies of individual working organizations if the significance of size is to be understood fully, and that investigations into the social and human factors are likely to provide the most valuable clues. Studies of the social effect on absenteeism of the distance of travel of the worker to his place of employment and of the effect of the number of hierarchical stages in the line of communication between the employee and the local manager are suggested as promising lines of inquiry.

Trends In Trade Union Organization

In 1894, the year when the Webbs published their first edition of the "History of Trade Unionism", the Labour Department of the Board of Trade recorded 1,314 trade unions with a total membership of 1,530,000. By the end of 1951 the number of unions had fallen to 704 and the total membership had reached 9,480,000. In 1894 the average number of members per union was 1,160, whereas in 1951 it was 13,452, a twelvefold increase. These broad statistical changes clearly indicate that trade unions have grown larger; but what they do not reveal is the degree to which union membership is concen-

trated in relatively few of them. In 1951 seventeen unions with a membership in excess of 100,000 accounted for 6,305,000 members. Although trade union membership is to-day highly concentrated, it is spread through a far greater range of occupations and industries than it was sixty years ago, when it was drawn in the main from a few that had become reasonably well organized during the nineteenth century. These changes in trade union structure and organization are described by P. C. Roberts in an article based upon considerable investigation and much practical experience in a recent issue of the Unilever magazine, *Progress* (43, No. 240, autumn 1953).

Investigations in Physics published in Russian and other Slavonic Languages

Among the resolutions passed during the General Assembly of the International Union of Pure and Applied Physics held in Copenhagen during 1952 was a recommendation that action should be taken to publish papers reviewing the work done in various fields of experimental and theoretical physics and published only in Russian and other Slavonic languages. As a result, the organization of this task was undertaken by the permanent secretariat of the Abstracting Board of the International Council of Scientific Unions, and a number of reviews of work done in the U.S.S.R. and countries of Eastern Europe have been prepared, each containing a bibliography on the subject in question. A supplementary number of the Italian journal of physics *Il Nuovo Cimento* is being prepared (Supp. to Vol. 10, Series 9) and will be available shortly, containing the following reviews: Soviet physics (J. Turkevich); mechanical twinning (R. W. Cahn); recent Soviet work in the field of crystallography (A. L. Mackay); crystallography in Eastern Europe (A. L. Mackay); théorie de la liaison chimique (M. Magat); sur les travaux de magnetisme en U.R.R.S. (S. Rosenblum); recent research on superconductivity in the U.S.S.R. (D. Shoenberg); Polish physics (W. J. Swiatecki); recent research on cosmic radiation in the Soviet Union (G. Wataghin); and recent Russian work on liquid helium (J. Wilks). The number of copies will be necessarily limited, and those wishing to order a copy who are not regular subscribers to *Il Nuovo Cimento* should write at once to either Nicola Zanichelli, Editore, Via Imerio N.46, Bologna, or to Prof. G. Polvani, Direttore, Via Saldini N.50, Milano. The price of the Supplement will be about 2500 lire.

Classification of Vegetation

In a search for objective methods to be used in the classification of vegetation, D. W. Goodall (*Austral. J. Bot.*, 1, 3, 435; 1953) has directed attention to the concept of fidelity as originally advanced by a Swiss school of plant ecology. This idea is bound up with the concepts of characteristic species; that is, plant communities were classified according to the presence or absence in them of small groups of 'characteristic' species much more common in one particular community than in any other. In the present investigation Goodall has attempted to express the concept of fidelity quantitatively. A new index of fidelity is described, based on the ratio of frequencies for the species in two communities. The importance of significance tests in determining characteristic species is emphasized. The value of a species as indicator of a particular

community is taken as the ratio of the frequency in that community to the frequency elsewhere within the area studied. An index to express this is proposed. The value of discriminant functions in enabling vegetation samples of uncertain affinities to be allotted to one of several possible communities is demonstrated. An example is given in which this technique has been used to determine whether one community can be regarded as intermediate between two others, or has special features of its own.

Radio Industry Council Premiums for Technical Writing

THE Radio Industry Council has awarded premiums of 25 guineas each for articles on radio published in the public technical press during 1953 as follows: G. G. Gouriet (spectrum equalization; *Wireless Eng.*, May); A. W. Keen (triode transformation groups; *Wireless Eng.*, October); A. H. Beek and A. D. Brisbane (a cylindrical magnetron ionization gauge; *Vacuum*, April 1952 and published April 1953); Dr. D. McMullan (the scanning electron microscope and the electron-optical examination of surfaces; *Electron. Eng.*, February); H. M. Davis and Miss J. E. Seaborn (a linear sweep cathode-ray polarograph; *Electron. Eng.*, August); J. R. Pollard (selective calling for radio-telephone systems; *Electron. Eng.*, December). The Radio Industry Council's Premiums for technical writing were first awarded last year by the Council for articles published in non-private periodicals during 1952, the object being to encourage the writing and publication of articles reporting technical progress and development of radio, television and electronics in Great Britain. Any writer is eligible who is not paid a salary wholly for writing and is earning less than 25 per cent of his income from fees from articles or from book royalties.

British Glaciological Society: Officers for 1954

THE following have been elected officers of the British Glaciological Society for 1954: *President*, G. Seligman; *Vice-Presidents*, Rt. Rev. W. L. S. Fleming, Bishop of Portsmouth, W. V. Lewis, K. Sandford and J. M. Wordie; *Chairman of the Committees*, V. E. Fuchs; *Secretary*, Mrs. H. Richardson (c/o Scott Polar Research Institute, Lensfield Road, Cambridge); *Honorary Treasurer*, T. H. Best; *Honorary Editor of the Journal of Glaciology*, G. Seligman (Little Dane, Biddenden, Ashford, Kent).

South African National Committee on Geochronology

THE first meeting has recently been held of the South African Committee on Geochronology, a new body which is under the sponsorship of the South African Council for Scientific and Industrial Research. The Committee has been formed "to take note of developments in this field in South Africa and overseas, and to do all it can to further them". Its members are at present: Dr. B. F. J. Schonland (*Chairman*), Dr. L. T. Nel, Dr. S. H. Houghton, Dr. E. J. Marais, Dr. D. Schreiner, Mr. R. T. Jamieson and Mr. J. D. Louw (*Honorary Secretary*).

Oil and Colour Chemists' Association: Sixth Technical Trade Exhibition

OWING to war damage repair work being undertaken at the Borough Polytechnic, the Sixth Technical Trade Exhibition of the Oil and Colour Chemists' Association will not be held there, as in former years,

but instead will be at the Royal Horticultural Society's Old Hall, Vincent Square, London, S.W.1, on the following dates and times: April 21 (3-8.30 p.m.), April 22 (2-8.30 p.m.) and April 23 (2-7.30 p.m.). One advantage of this change is that the entire exhibition will be housed in one hall. An exhibition luncheon will take place, as in former years, at the Criterion Restaurant, Piccadilly, London, W.1, on April 21, tickets (one guinea each) for this function being restricted to members of the Association and to two per exhibitor. Applications for these tickets and for copies of the exhibition brochure should be made to the General Secretary, Oil and Colour Chemists' Association, Memorial Hall, Farringdon Street, London, E.C.4, from whom all further information can be obtained.

Fourth International Conference on Electrodeposition and Metal Finishing, London

THE Fourth International Conference on Electrodeposition and Metal Finishing will be held in the Holborn Restaurant, 218 High Holborn, London, W.C.1, during April 20-24. The Conference, which is under the aegis of the International Council for Electrodeposition, will be organized by the Institute of Metal Finishing. About two dozen papers will be read, and a session of particular interest will be one at which a panel of American experts will answer questions relating to practice in the United States. An exhibition of techniques and equipment will be held in conjunction with the Conference. Further information can be obtained from the Conference Secretary at the Institute of Metal Finishing, 32 Great Ormond Street, London, W.C.1.

Royal Society Lectures

THE following arrangements have been made for Royal Society Lectures during 1954: Leeuwenhoek Lecture, by Prof. J. H. Quastel, professor of biochemistry, McGill University, Montreal, and director of the Research Institute, Montreal General Hospital, on "Soil Metabolism" (May 6); Croonian Lecture, by Sir Howard Florey, professor of pathology in the University of Oxford, on "Mucins and the Protection of the Body" (May 27); Bakerian Lecture, by Prof. A. R. Todd, professor of chemistry in the University of Cambridge, on "Chemistry of the Nucleotides" (June 17).

The Night Sky In March

NEW moon occurs on March 5d. 03h. 11m., U.T., and full moon on March 19d. 12h. 42m. The following conjunctions with the moon take place: March 11d. 13h., Jupiter 3° S.; March 23d. 02h., Saturn 8° N.; March 26d. 15h., Mars 3° N. Mercury is in inferior conjunction on March 1, after which it is a morning star but is unfavourably placed for observation during the month. Venus, an evening star, sets at 18h. 10m., 18h. 55m. and 19h. 45m. on March 1, 15 and 31, respectively. Most of the illuminated portion of the disk is visible, and the stellar magnitude is -3.4 throughout the month. Mars, a morning star, rises at 2h., 1h. 40m. and 1h. 15m. at the beginning, middle and end of the month, respectively, stellar magnitude 0.8-0.2. The great change in brightness is due to the decrease by 27 million miles in the planet's distance from the earth. Jupiter is visible throughout the night, setting in the early morning hours at 2h. 35m., 1h. 45m. and 0h. 50m. on March 1, 15 and 31, respectively, stellar magnitude -1.8. Saturn is an evening star, rising at 23h., 22h. and 20h. 55m. at the beginning, middle and end of the

month, respectively, stellar magnitude 0.6-0.5, and is easily identified in the constellation Libra a little north-west of α Libra. Occultations of stars brighter than magnitude 6 are as follows, observations being as if made at Greenwich: March 11d. 21h. 30.4m., 118 Taur. f (D); March 13d. 18h. 37.9m., 8 Gemi. (D); March 13d. 19h. 44.6m., 8 Gemi. (R); March 13d. 23h. 03.9m., 63 Gemi. (D); March 16d. 22h. 41.4 m., 83 B. Leon. (D); March 17d. 1h. 43.8m., π Leon. (D). D and R refer to disappearance and reappearance, respectively. Vernal equinox takes place on March 21d. 04h.

Announcements

THE essay subjects for this year's *Endeavour* prizes of the British Association for the Advancement of Science will be as follows: the upper atmosphere; heat of the earth; coal as a raw material; water supply; the span of life; and colour photography. Essays must be sent in by June 1 and must not exceed four thousand words. Competitors must be twenty-five years old or less on June 1 and the prizes will be 50, 25 and 15 guineas respectively, with two special awards of 5 guineas for those less than eighteen. Further information can be obtained from the Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1.

DR. R. BRAUDE, of the National Institute for Research in Dairying, has been appointed adviser on pig research to the Agricultural Research Council. The post will only occupy part of Dr. Braude's time, leaving him free to continue active research in this field. He will also act as technical secretary to a committee which is being set up by the Council to review and co-ordinate existing research on pigs, and to propose such other work as is thought desirable.

THE Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland are offering a number of postgraduate scholarships in agricultural economics, husbandry, statistics and agricultural and dairy engineering, for the academic year beginning next October. The closing date for applications is March 15. Further particulars can be obtained from the Secretary, Ministry of Agriculture and Fisheries (Research Branch), 1-4 Cambridge Terrace, Regent's Park, London, N.W.1 (to whom residents in Northern Ireland should also apply), or the Secretary, Department of Agriculture for Scotland, St. Andrew's House, Edinburgh 1.

THE first part of *Current Chemical Papers* has now been issued by the Chemical Society (No. 1, pp. 44; 1954) and contains the titles, with authors' names and references to the original, of publications received during the whole of the previous month. The entries are classified in ten groups and cover the whole field of chemistry. There will be no index to the publication. Further particulars can be obtained from the Chemical Society, Burlington House, London, W.1.

THE final volume of "Thorpe's Dictionary of Applied Chemistry", announced by Messrs. Longmans Green in *Nature* of February 20 (Advert. Supp. p. ii), as for publication this month, will not be ready until the early summer.

ERRATUM. In the communication "Pigmentation of the Jellyfish, *Pelagia noctiluca*" (*Nature*, January 23, p. 169, par. 7, lines 8 and 9, for "but no pyrrole reaction on roasting" read "and a pyrrole reaction on roasting").

ATOMIC ENERGY RESEARCH AT HARWELL*

THE Atomic Energy Research Establishment at Harwell is responsible for research into all the problems of atomic energy except those relating to atomic weapons, which are studied at the Armament Research Establishment under Sir William Penney at Aldermaston.

The work at Harwell is mainly applied research on the development of new types of nuclear reactors and their civil applications. Two research reactors, GLEEP and Bepo, have already been built, and help was given in designing the plutonium production reactors at Risley. This work requires the solution of many chemical and metallurgical problems, and a large staff of scientists is required to study them. A by-product of the reactor programme is the manufacture of radioisotopes, and many consignments of them are now sent to assist medical, agricultural and industrial research all over the world.

Nuclear reactors are assemblies of uranium either in its natural proportions or enriched in the proportion of uranium-235, together with other materials known as moderators, in such quantities and proportions that a sustained nuclear chain reaction is established producing fissions of the light isotope of uranium at a steady rate. The moderator slows the neutrons down to thermal energies, at which they have a much greater probability of causing fission. The designer of a reactor is faced by a host of complex problems. He has to make sure that at least one, on the average, of the neutrons emitted from a nucleus undergoing fission eventually causes another fission, so that the reaction is maintained in spite of the fact that neutrons are lost by capture in the moderator and structural materials, or by escape from the reactor.

Three groups of physicists are concerned with reactor design. Theoretical workers calculate how the neutrons behave in a reactor of any specified design, and then the reactor physicists build a sub-critical reactor to confirm their predictions. The solid-state physicists estimate how well the proposed structural materials will stand up to the intense neutron bombardment inside a reactor.

The designer is very restricted in his choice of materials by the requirement that they must not capture many neutrons. The only practicable moderators are graphite, heavy water, beryllium and ordinary water. Each of these has its advantages but also its disadvantages, so the designer has to make a choice to suit the type of reactor required. Another problem is the choice of fluid to transfer the heat from the reactor to the power unit. The first British nuclear power plant will use carbon dioxide as the heat-transfer medium and graphite as the moderator.

As the reaction proceeds, the uranium-235 is destroyed by fission and almost replaced by plutonium-239 formed from uranium-238 by neutron capture. As the fission products themselves capture neutrons, there comes a time when they absorb so many that the reaction stops. It is therefore necessary that they should be removed; it is sometimes

desirable also to extract the plutonium, for it has many important uses. Several groups at Harwell are studying the complex chemical and engineering problems of the extraction and utilization of plutonium and fission products. The latter used to be regarded as waste; but now many industrial uses are being found for them.

Since radiations injurious to the human body are emitted by nuclear reactors, it is necessary to study the biological effects of atomic radiations and establish strict safety regulations. This has now been done so effectively by the Health Division at Harwell that the danger of radiation injury is negligible.

Such are some of the many problems which have arisen in the development of the first power reactor in Great Britain. Each new type of reactor brings in a new set of problems, often requiring the separation of some rare metal and the determination of its chemical and metallurgical properties. Fast reactors are now being extensively studied as they are potentially important as breeders of nuclear fuel. They use no moderator, and the reacting volume is very small, which makes the heat-transfer problems more difficult to solve. Furthermore, the neutron flux is much greater in these reactors; this intensifies the problem of finding materials able to retain their mechanical properties. To assist in these studies a materials testing reactor with a very high neutron flux is being designed at Harwell to study the behaviour of materials under intense neutron bombardment.

All these technological developments depend on the researches of the nuclear physicists, who determine the fundamental nuclear constants which have to be known before a reactor can be designed. It is very important, for example, to know accurately the average number of neutrons emitted per fission of uranium-235 or plutonium, and how they react with the materials used in building the pile.

Apart from these studies directly related to reactor development, there are many research groups at Harwell working on fundamental problems, such as the nature of nuclear forces, with no immediate practical application in view. Among the instruments used is a cyclotron which can accelerate protons to 180 MeV., and a 600-MeV. proton linear accelerator is being built. The chemists have groups working on the elements beyond plutonium, on solid-state chemistry and on radiation chemistry. All this work is done in close collaboration with the universities—an arrangement which is mutually beneficial.

Many new kinds of electronic devices which are indispensable in nuclear research are being developed, and some of these are being built in large quantities by industry for other research laboratories and for civil defence. An electronic calculating machine using transistors is being built to solve the computing problems of the theoretical physicists.

Harwell is organized into a number of divisions, each dealing with one aspect of atomic energy and composed of up to ten research groups each studying a particular problem. The work of the different groups and the focusing of the research on to special projects is arranged by a number of committees or informal working parties. Every effort is made to avoid excessive formalities and in this the administrative staff has co-operated very fruitfully.

* Summary of a lecture by Sir John Cockcroft, being the first of a series of public lectures arranged by the Atomic Scientists' Association and the Department of Extra-Mural Studies of the University of London. The complete series of six lectures will appear in the March and subsequent issues of the *Atomic Scientists' Journal*, and also as a book entitled "News and Views on Atomic Energy", to be published by Messrs. Taylor and Francis, Ltd.

MICRORADIOGRAPHY AND AUTORADIOGRAPHY

A SYMPOSIUM on microradiography and autoradiography was held on December 17, 1953, at the Institute of Physics, 47 Belgrave Square, London, by the Scientific and Technical Group of the Royal Photographic Society. Many modern scientific methods are intimately connected with photographic techniques, and it can be regarded as very fortunate that biological and medical research workers and photographic scientists were able to meet one another at such an occasion to discuss their methods and also their results.

The first part of the meeting was devoted to microradiography and gave evidence of the potentialities and limitations of the method. From recent physical and technical developments on X-ray beams from very small focal spots, new possibilities may be expected. The first speaker, Prof. G. A. G. Mitchell (Anatomy Department, University of Manchester), explored the potential uses of microradiography of biological objects, such as body tissues, leaves, seeds, fibres, hairs, insects, wings, ova, small crustacea, etc. He has tried methods of enhancing contrast by using various injections and by soaking or impregnating tissues and materials with solutions which are more-or-less radio-opaque; he has also tested material with and without preliminary freeze-drying. Prof. Mitchell came to the conclusion that in most respects microradiography is less valuable than histological and histochemical methods in investigating the structure and composition of biological objects. On the other hand, the following advantages of microradiography were stressed: much thicker sections can be examined and thus the arrangement of various structures can be traced over greater distances than is possible in ordinary histological sections 5–10 μ thick; structures containing bone or calcareous deposits can be examined without preliminary decalcification; normal or abnormal deposits of radio-opaque substances are readily detectable; and the distribution of vessels and tubules can be studied accurately and fairly rapidly by the method.

Mr. R. V. Ely (London) dealt almost exclusively with the requirements of apparatus such as 'sealed off' and 'demountable' X-ray tubes, backing and diffusion pumps, valves, vacuum gauges, high-tension and filament supply units, mains voltage stabilizers, vacuum cassettes, etc. A demountable X-ray tube developed by Mr. Ely permits easy removal of the window in order to attach an extension cylinder holding a quarter-plate at a considerable distance from the target. The apparatus can be used for photographic as well as for direct magnification; in the latter case only very small focal spots are permitted.

Whereas the first two speakers chiefly dealt with magnifications up to 500 times, the third speaker, Dr. V. E. Cosslett (Cavendish Laboratory, Cambridge), looked for magnifications of the order of one thousand diameters and above. He therefore prefers the term 'X-ray microscopy' to microradiography. Since the optical resolving-power is limited to about 0.5 μ by the wave-length of light, a higher resolving-power should be possible using X-rays of a wave-length of the order of 1 Å. As the contrast attainable is roughly proportional to the cube of the wave-length of the X-rays, practical considerations demand the use of wave-lengths of one or several angstroms (that is, 12-kV. X-rays and less are required). Four

basic methods of X-ray microscopy were suggested: the conventional contact method, where object and film are in close proximity; three other methods which entail direct magnification by means of curved crystals, by mirror reflexion and end-window X-ray tubes, respectively. The relative merits of these four methods were reviewed, and the end-window technique that has been developed by Dr. Cosslett was described in greater detail. It involves the production of an ultra-fine focus on an end-window target, using electron optical techniques. The use of very thin windows makes high X-ray intensity available from spots of the order of 1 μ in diameter. At present, Dr. Cosslett and his co-workers are attempting to obtain a focal spot of the order of 0.1 μ . High direct magnification is obtained by bringing the specimen close to the window. Several examples of Dr. Cosslett's method for examining the microstructure of biological and metallurgical specimens were shown. Photographs have been taken of living insects, in which great interest is being shown at the present time, in order to follow up radiation damage in insects when exposed to various X-ray doses.

The second part of the meeting was entirely devoted to biological autoradiography. The techniques of micro-autoradiography are mainly based on the use of stripped nuclear-track emulsions. At present the refinement of methods appears to be in the foreground of autoradiographic investigations and, in particular, a deeper insight into the problems of resolution and quantitative uptake of radioisotopes is required. Dr. S. R. Pelo (Experimental Radiopathology Research Unit, Hammersmith Hospital, London) reviewed autoradiography by discussing the possibilities and limitations of the method, the planning and design of experiments and the interpretation of the results. The incorporation of radioisotopes into chemical compounds in the organism depends on the correct choice of the chemical compound of interest and the concentration, which in turn is dependent on the sensitivity of the film material to be used. Formulae which relate the concentration in terms of micro-curies per c.c. and of half-lives of the tracer were given. An estimate of the amount required depends also on the frequently unknown distribution within the organism. It was shown, for example, that, by administering sulphur-35 as sulphate ion, it finds its way into the cells of the cartilage of the trachea and very little is taken up by the epithelial lining. After injection of sulphur-35 as *D*-methionine (³⁵S), significant accumulation of the isotope is found in the epithelial cells and only a faint trace in the cells of the cartilage. In the preparation of the specimens, special care has to be taken in regard to possible loss of radioactive compounds due to solvents and also to the possibility of the formation of artefacts that are caused, for example, by chemical interaction between specimen and photographic material. Several examples of the possible ambiguity and pitfalls in interpretation were given.

Dr. L. F. Lamerton (Department of Physics, Royal Cancer Hospital, London) discussed problems involving the resolution and sensitivity in autoradiography. In contrast to the theoretical treatment of resolution by Doniach and Pelo, Dr. Lamerton defines resolution as the distance d if the images of two uniformly active cylindrical sources of diameter d can just be resolved when the centres are separated by a distance $2d$. A table was given showing the resolution, in terms of microns, obtainable theoretically for various emulsion and specimen thicknesses

and for various distances between specimen and film. In addition there are two further factors which limit the high resolution otherwise attainable. These are the unavoidable background due to chemical fogging and cosmic rays, and the cross-fire of radiation from surrounding parts of the specimen. With reasonable precautions, the background may be reduced to about 4 grains/100 μ^2 or less. From a theoretical treatment of the cross-fire radiation (based on a relation between grain density and distance from a point source), it is shown that an autoradiograph will be recognizable above a structure of cellular dimensions only if the concentration of the activity within the structure is a number of times greater than that of the surrounding specimen. This concentration must be higher for long-range electrons, that is, greater with phosphorus-32 than with sulphur-35 or carbon-14. Dr. Lamerton referred also to a new Kodak X-ray stripping-plate which fills the gap in sensitivity and resolution between the fast X-ray film and the relatively slow nuclear-track stripping-plate.

Dr. L. G. Lajtha (Radiotherapy Department, Churchill Hospital, Oxford) described a high-resolution autoradiographic stripping-film technique adapted to smears made from human bone-marrow cultures *in vitro*. In such a smear the cells are separated sufficiently from each other to prevent 'cross-fire', and good results have been obtained by floating the emulsion at 25° C. on distilled water for 4-6 min. The autoradiographs were stained after processing to facilitate recognition of the individual cells. The method is sensitive enough to detect and localize as little as 20-30 phosphorus-32, or 30-50 sulphur-35, atoms per cell.

Experiments on the mechanism of deoxyribonucleic acid synthesis as measured with phosphorus-32 and adenine (¹⁴C) were described. Experiments on sulphate (³⁵S) uptake have shown that uptake of inorganic sulphate (³⁵S) and its incorporation into a substance related to the chondroitin sulphates is a specific function of the myeloid cells in the bone marrow.

THE BOSE INSTITUTE, CALCUTTA

THE thirty-sixth anniversary meeting of the Bose Institute took place on November 30, 1953, when Dr. N. K. Bose, director, River Research Institute, delivered the sixteenth Acharya Jagadish Chandra Bose Memorial Lecture on "The Role of Silt and Sand in Multipurpose River Valley Projects".

Dr. D. M. Bose, director of the Bose Institute, in presenting his report on the working of the Institute for the past year, said that completion of many important projects commenced during the past few years was being delayed for want of funds. He mentioned that early this year the Institute had acquired a plot of forty bighas of good agricultural land at Shamnagar, near Barrackpur, for erection of an experimental station for certain fundamental investigations in plant sciences which the Institute proposes to undertake. The Institute had to obtain a loan of Rs. 60,000 for this purpose. For the erection of necessary residential quarters and laboratory buildings and for electric installation and for fencing the estate about Rs. 1 lakh will be required.

The investigations which the Institute has been carrying out during the past few years on the action of X-radiation in producing mutations in a few economic plants have obtained a certain amount of

recognition, and the Institute has, on invitation from the National Institute of Sciences of India, submitted a five-year scheme, which may be extended by another five years, of fundamental investigations on the mutagenic action of different kinds of radiations on plants. The latter will be selected mainly for their suitability for genetic studies.

Preliminary investigations started during the past year have disclosed that the beta-radiation from radioactive phosphorus, which is selectively absorbed in plant nuclei, is a very convenient tool for inducing mutation in plants; for example, with this method, new types of effects are being obtained in certain varieties of jute plants in addition to those obtained with the same kind of plants after irradiation trials with X-rays extending over many years.

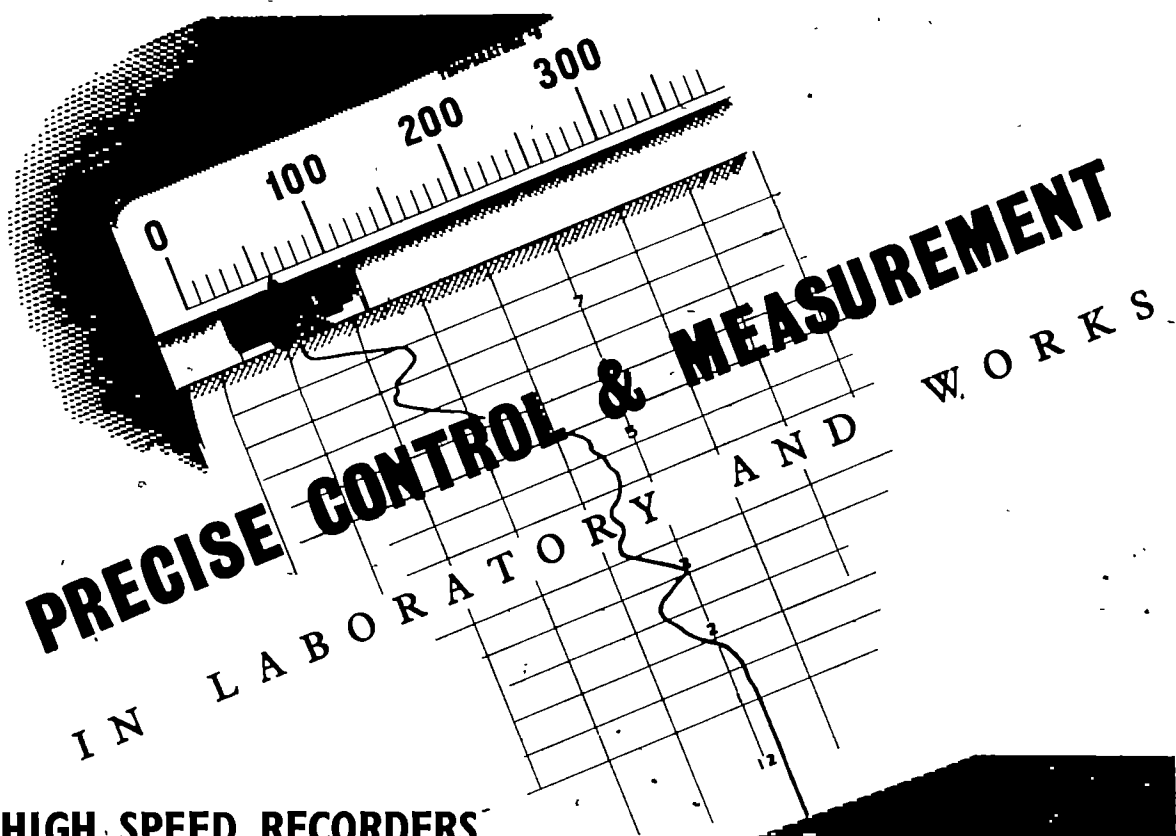
At Mayapuri, Darjeeling, a plant pathological laboratory was begun about three years ago as an experimental measure. Already valuable work has been started on the breeding of new hybrids of potatoes resistant to several virus and fungal infestations, using locally available potatoes as one of the parents and imported resistant strains as the other. This work is being undertaken in co-operation with the West Bengal Seed Potato Farm at Rungbul, near Darjeeling. The Institute has already done some good work in detecting the presence of potato wart disease, hitherto not known to occur in India, in one of the plots at Rungbul sown with an imported variety of potatoes known as Eureka. This observation when published in *Science and Culture* attracted the attention of the Ministry of Agriculture, Delhi, and resulted in a visit to Darjeeling of the director of potato research and the deputy director of plant protection for inspection of control measures. Studies of other potato diseases of bacterial origin have resulted in the receipt for examination from different parts of India of similar infected potato tubers. Without more financial assistance the Institute cannot indefinitely maintain the Plant Pathological Laboratory, which will be compelled to close.

Mayapuri is also being developed as a centre for cosmic ray research. On a request from the Council for Scientific and Industrial Research, India, a scheme with detailed plans and estimates for erection of a laboratory and workshop for cosmic ray research has been submitted. There will also be accommodation for guest workers who may come to Mayapuri for cosmic ray work.

The Institute has received a new grant from the Board of Research on Atomic Energy for investigations on the use of radioactive isotopes of carbon and phosphorus for studying photosynthesis and the mutagenic action of beta-rays of phosphorus. In a recently formulated five-year plan of research the Institute has included a proposal for the study of photosynthetic utilization of solar rays as a method for food and power production and of its economic feasibility.

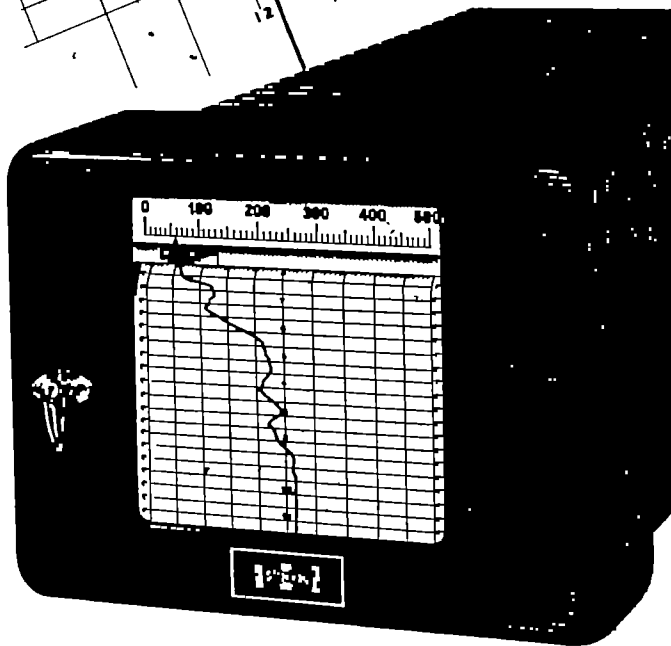
The microbiology department has received a grant from the Council for Scientific and Industrial Research, India, for the production of antibiotics isolated from *Streptomyces* spp. which has some remarkable bactericidal properties.

Besides these new schemes, the Institute is continuing to receive the usual grants-in-aid from the Board of Research on Atomic Energy, the Central Jute Committee, the Central Oil Seeds Committee, the Cotton Committee of West Bengal, I.C.A.R. grant for weed control, and the B.O.C. grant for paleobotanical research.



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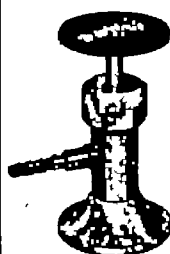
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COUNTY DETAILS OF THE CENSUS OF WOODLANDS, 1947-49

THE Forestry Commission Census Reports, Nos. 1 and 2, dealing respectively with the woods less than and more than five acres in extent (the latter including hedgerow and park timber) have already been reviewed in *Nature* (August 8, p. 240, and October 3, p. 616), and they have now been supplemented by three further issues—Census Reports Nos. 3, 4 and 5—giving the details for the Welsh, Scottish and English counties respectively as deduced from the Census of Woodlands 1947-49*. The details are given by counties for these larger woods, the additional figures being for areas only, as the information is not available for standing volume or annual growth. Distribution as between the Forestry Commission and Private Woodlands is shown in all the nine tables given in standard form for each county. National totals are usefully given even where this means some duplication of information given in Report No. 1.

In addition to showing the break-down of the totals of Report No. 1 into county figures, fuller detail is given in certain other respects. Thus the age-class structure of the several categories of high forest is shown by decades for 0-40 years and by twenty-year periods between 40 and 80 years, followed by two classes for the older woods, namely, 80-120 and more than 120 years. This detail will be useful for many purposes owing to the big differences in immediate utility, rate of growth, current yields as thinnings, etc., between crops of different age, which are such that the grouping into only two classes above and below 40 years is inadequate.

The fuller detail for the areas under the different tree species is similarly very necessary since the distribution is so widely different from county to county—and here, too, age-classes are differentiated, while separate tables are given for pure stands only as well as for mixed and pure stands together. Thus the basic data are now available for determining what area of spruce or poplar might be available in any section of the country from which to draw supplies for existing or contemplated industries.

Information is also given for six more of the less commonly grown conifers and six more hardwoods, revealing how little we still have of them, even of poplar (1,466 acres, though this is only for woods more than five acres in extent). It can similarly now be seen where the scrub and devastated woodlands are concentrated and how much of these areas is thought to be suitable for economic management.

These reports are in foolscap size, the counties being arranged in alphabetical order, and the tables

* Forestry Commission. Census of Woodlands 1947-49: Woods of Five Acres and Over. Census Report No. 3, Welsh County Details; pp. vii+90; 4s. 6d. Census Report No. 4, Scottish County Details; pp. vii+187; 10s. 6d. Census Report No. 5, English County Details; pp. vi+270; 12s. 6d. (London: H.M.S.O., 1953.)

are reproduced in a clear and convenient form so that reference is easy. The only regret is that one has to be content with area data where one usually needs volumes.

H. G. CHAMPION

OXIDATION OF PHENYL-HYDRAZINES IN THE PRESENCE OF OXYHÆMOGLOBIN AND THE ORIGIN OF HEINZ BODIES IN ERYTHROCYTES

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Department of Pathology (Haematology), Postgraduate
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THE occurrence in phenylhydrazine (Ph.NH.NH₂) poisoning of a hæmolytic anemia with Heinz inclusion bodies in the erythrocytes is well known. Such inclusions also form rapidly in normal erythrocytes on *in vitro* incubation at 37° with phenylhydrazine¹. With destomatized oxyhæmoglobin solution and excess of various substituted phenylhydrazines, the oxyhæmoglobin is degraded and precipitated as a 'green hæmoglobin' with composition similar to that of the Heinz bodies, while the hydrazine undergoes oxidation. The process is strictly aerobic, though at low oxygen tension other changes in the oxyhæmoglobin may occur with the more reactive hydrazines, such as choleglobin formation without any formation of green precipitate. The aerobic oxidation of long-chain, unsaturated fatty acids is also catalysed by oxyhæmoglobin, which is decomposed and converted to colourless substances². In these reactions, oxyhæmoglobin is "the catalyst of its own destruction"³, while acting as the last link in the utilization of molecular oxygen⁴.

Oxidation of Arylhydrazines

Experiments were performed in Dreschel bottles, and volatile products of oxidation swept over by air or oxygen into ethanol. In the presence of oxyhæmoglobin, excess phenylhydrazine and acetylphenylhydrazine (Ph.NH.NH.CO₂Me) yield as end-products nitrogen and benzene, the latter being detected by its ultra-violet absorption spectrum.

When present in excess, the oxyhæmoglobin is itself oxidized to methæmoglobin (MetHb), and with 2:4-dinitrophenylhydrazine and *asym*-diphenylhydrazine this reaction alone occurs, no green hæmoglobin being formed.

Benzene is not formed from phenylhydrazine or acetylphenylhydrazine in the presence of reduced hæmoglobin (Hb) and nitrogen, and similarly with methæmoglobin only a trace of benzene is formed, but a much larger production occurs on admission of oxygen. With oxyhæmoglobin, less benzene is formed under anaerobic than under aerobic conditions. Spectroscopic evidence suggests that reduction of oxyhæmoglobin or methæmoglobin precedes degradation. Similar aerobic reactions, with insoluble 'green hæmoglobin' production, occur with phenylhydrazine-*p*-sulphonic acid; with *o*- or *p*-nitrophenylhydrazine, the volatile oxidation product is nitrobenzene.

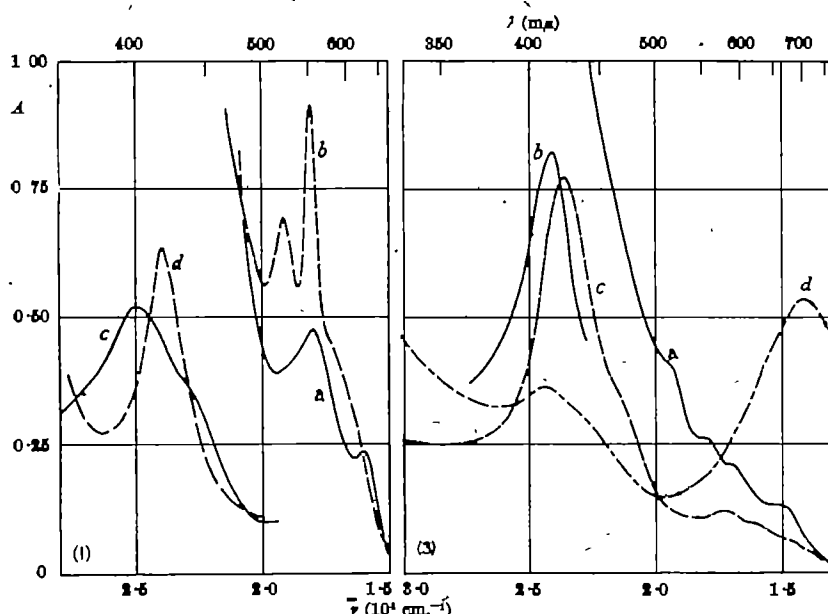


Fig. 1. Neutral acetone extract of 'green hemoglobin' precipitate from aerated oxyhaemoglobin-acetylphenylhydrazine system. (a) —, Neutral acetone extract, diluted 1:10; (b) ---, neutral acetone extract diluted 1:10 with 30 per cent aqueous pyridine, followed by dithionite

The two curves have been separated slightly on the absorbance scale for increased clarity (a) —, As (a), diluted 1:100; (d) ---, as (b), diluted 1:100

The scales of all the figures are linear in wave-number ($\bar{\nu}$) and absorbance (optical density)

Fig. 2. (a) —, Iron-free green pigment from acid-treated 'green hemoglobin' precipitate in chloroform; (b) —, as (a), diluted 1:5; (c) ---, as (b), in 30 per cent hydrochloric acid; (d) -.-.-, blue-green 'biliverdin-type' pigment from acid-treated 'green hemoglobin' precipitate, in 30 per cent aqueous pyridine

Arylhydrazines are readily oxidized by atmospheric oxygen⁸, but only traces of benzene or nitrobenzene have been obtained from aerated aqueous suspensions of phenylhydrazine or *p*-nitrophenylhydrazine. These findings point to an oxidation-reduction system between the oxyhaemoglobin and the arylhydrazine, with hydrogen transfer from the latter to molecular oxygen, while the oxyhaemoglobin undergoes irreversible changes. The oxidation of acetylphenylhydrazine by potassium ferricyanide is also catalysed by oxyhaemoglobin with appreciable production of benzene and conversion of the pigment to 'green hemoglobin' precipitate.

The oxidation by molecular oxygen may involve hydrogen peroxide, but the rate of oxidation of acetylphenylhydrazine does not appear to be affected by 0.0025 *M* potassium cyanide added to depress catalase activity. (S. Brenner and A. O. Allison (*Experientia*, 9, 381; 1953) have since pointed out, however, that many toxic substances producing Heinz bodies are themselves catalase inhibitors, and suggest that catalase inhibition may be the first step in the production of Heinz bodies in intact erythrocytes.) The system arylhydrazine/oxyhaemoglobin possesses certain

similarities to the aerobic phenylhydroxylamine/oxyhaemoglobin system of Keilin and Hartree⁹, in which nitrosobenzene is formed and co-ordinates with the haem of the haemoglobin. When oxyhaemoglobin is aerated in the presence of excess nitrosobenzene, we find that the purple complex decomposes and a typical 'green haemoglobin' precipitate forms.

The intermediate products have not been characterized in our work, with the exception of phenol. Benzene is the ultimate product of oxidation of phenylhydrazine or acetylphenylhydrazine, possibly arising via the diimide $\text{PhN}=\text{NH}$, but the yield is small under our conditions.

The 'Green Haemoglobin' Precipitates

The insoluble 'green haemoglobin' is complex, containing haems and other iron-containing pigments bound to denatured globin. The relationship to choleglobin and denatured choleglobin haemochrome¹⁰ is not clear; the former can often be detected, but may not be related directly to the formation of the 'green haemoglobin', and indeed is most abundant in poorly-oxygenated systems where no green precipitate is formed. Certain features of the green precipitate formed in the presence of acetylphenylhydrazine have been clearly established:

(1) Neutral acetone extracts a haem with bands at 400, 557 and 625 $\text{m}\mu$ (Fig. 1), giving a typical

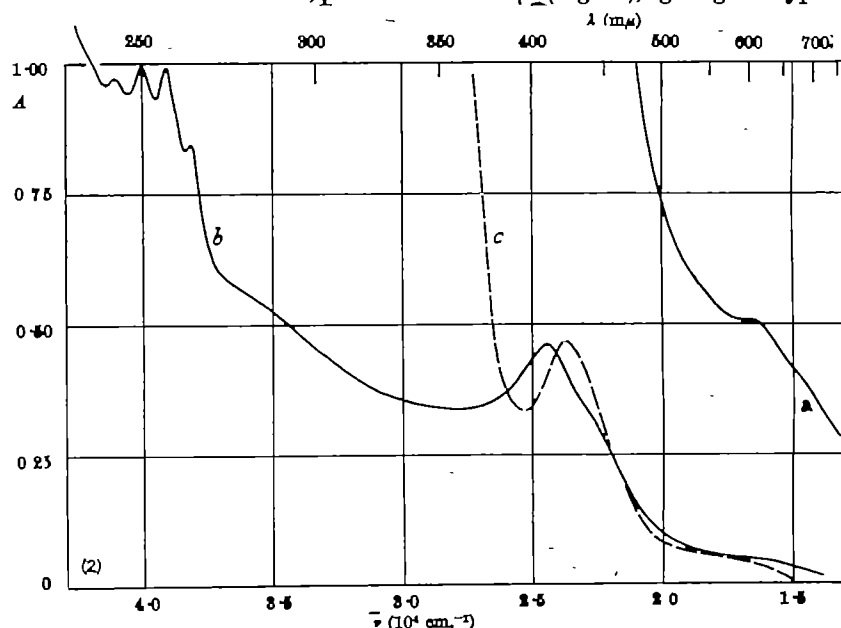


Fig. 2. (a) —, Green pigment liberated from 'green hemoglobin' precipitate by peptic digestion, in water; (b) —, 1:5 dilution of (a); (c) ---, solution (b) after dithionite

haemochrome spectrum with pyridine and dithionite with maxima at 418, 525 and 557 m μ . More haem is extracted by acid acetone.

(2) The haem is a protohaem, since protoporphyrin and mesoporphyrin (ratio c. 10:1) are the only porphyrins isolated after treatment of the 'green haemoglobin' with sodium amalgam. Normal haemoglobin gives the same porphyrins in similar ratio under these conditions¹⁰, but in much higher yield.

(3) Protein-bound haem is most abundant during the early stages of the formation of green precipitate, when the colour is predominantly brown-green. Later, the haemochrome reaction is weaker, but iron-containing green pigments are still present. Secondary changes lead to very firm binding of the pigments to the protein, so that acid acetone no longer extracts them completely, and the precipitate loses its solubility in aqueous urea solution, though remaining soluble in glacial acetic acid.

(4) The green pigments are liberated as water-soluble peptides by peptic digestion. A Soret-type absorption band occurs (Fig. 2) at 410 m μ , moving to 423 m μ on dithionite reduction. An inflexion at 605 m μ is the only other feature in the visible region. Ferric iron is rapidly liberated from the green pigment in 2.5 N hydrochloric acid (cf. ref. 11), leaving chloroform-soluble green pigments which still possess an absorption band at 410 m μ (Fig. 3).

(5) Derivatives resembling verdohaemochrome¹² were not obtained. None the less, the presence of acid-labile iron and the persistence of a Soret-type absorption band suggests that the porphyrin ring has not been opened, and that the protein-bound green pigment is not of the bile-pigment type. Most attempts to obtain bile pigments from the green precipitate, either directly or after treatment with hydrochloric acid or acetic acid, have failed. However, on one occasion hydrochloric acid-acetone extracted a blue-green pigment with biliverdin-type band at 705 m μ , but an anomalously weak band at 410 m μ (Fig. 3).

Heinz Body Anaemia

The relationship of the 'green haemoglobin' precipitate to Heinz bodies in erythrocytes was studied in a case of poisoning by acetylphenylhydrazine, and also in erythrocytes incubated with this compound. Heinz bodies remained attached to the stroma after laking the erythrocytes. Denatured globin was demonstrated by staining after susa fixation in a mixture of orange G and aniline blue at pH 3; the bodies stained orange, as does the haemoglobin in intact erythrocytes, whereas the stromal protein was blue¹³. Stromal lipid, which stained with sudan black, was present at the periphery of the bodies.

Repeated washing of the residue after laking yielded a brownish-green mass of Heinz bodies. Pyridine extraction gave the pyridine haemochrome spectrum (λ_{max} 418, 525 and 557 m μ), intensifying with dithionite. Extracts with 0.1 N hydrochloric acid, ethanol and 0.2 N potassium hydroxide had Soret-type absorption bands at 398, 402 and 407 m μ respectively. The soluble oxyhaemoglobin from the patient's erythrocytes was normal and no methaemoglobin or choleglobin was detected.

In the various extracts of experimentally produced 'green haemoglobin' precipitate, benzene was frequently detected (Fig. 2). It is noteworthy that in anaemia of swine caused by phenylhydrazine, Lawson *et al.*¹⁴ observed typical haemolytic anaemia in

five animals, but a fatal aplastic anaemia in the sixth, the features of which resembled benzene poisoning.

We wish to thank Dr. E. R. Holiday for spectrographic facilities and Dr. E. A. Johnson for assistance with some of the experimental work.

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INFLUENCE OF TEMPERATURE AND SOIL WATER CONTENT ON THE SEEDLING BLIGHT OF MAIZE

By JOHN L. HARPER

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IN northern temperate climates, a serious problem in maize cultivation is that the growing season is usually too short to allow the grain to ripen¹. It is therefore desirable to plant as early as possible. However, early plantings seldom give a good stand because in the germination phase the grains are attacked by pathogenic fungi. Varieties of maize differ in their resistance to this 'seedling blight' and a variety of laboratory techniques have been devised to assess the resistance of newly bred varieties. These tests usually involve planting the grain in jars or trays of soil, which are then exposed to low temperatures, usually between 7° and 10° C. for a period of 8-10 days. After this treatment the grain is allowed to germinate at some favourable temperature, usually 20-25° C. The proportion of grains which fail to germinate gives a measure of the resistance to seedling blight or what is sometimes loosely called 'cold hardness'².

The length of the exposure and the temperatures to which the grains are subjected vary from worker to worker, and apart from the pioneer work of Dickson³, who studied infection by *Gibberella zeae*, there has been no previous attempt to investigate in a detailed manner the comparative effects of exposure to different temperatures or to determine the influence of soil moisture content on the liability of maize grains to pathogenic attack in the soil. It was felt that a study of the conditions affecting seedling mortality of maize might give some information on the general behaviour of soil-borne pathogens at various soil moistures and temperatures.

For these experiments one variety of maize was used, namely, Virginian White Horsetooth, which is grown fairly widely as a forage crop in Great Britain and which was known to be liable to damage in cold

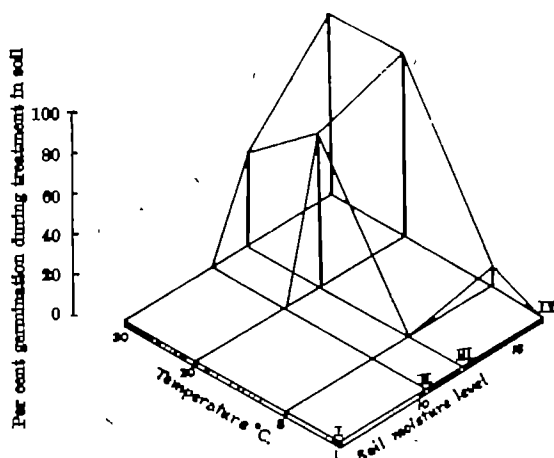


Fig. 1. The germination of White Hornetmouth maize in soils of various moisture contents and at various temperatures. Soil moisture level in Figs. 1 and 2 is expressed as percentage increase in weight of dry maize grains after incubation in soil at 20° C. for 24 hr.

springs. Soils for this experiment were sampled from plots on which maize had been grown for two years previously. After collection in the late summer the soil was spread on a clean barn floor and turned every day for five days and then divided into four parts. To one part enough water was added to bring the soil to its sticky point. The amount of water needed to do this was measured, and a half and a quarter of this amount were added to two of the remaining samples. The fourth sample was maintained dry. Each soil sample was well mixed and allowed to stand for six hours to allow the water to be evenly distributed. Each sample was then mixed again, and sub-samples were placed in 1-lb. jam jars and sixteen maize grains were planted in each jar. Eighty of these jars were prepared, twenty from each soil sample, and each set of twenty was distributed at random between four incubators at 1°, 8°, 20° and 30° C. For each soil moisture/temperature combination there were five jars, and one of these was withdrawn after 3, 6, 9, 12 and 15 days. After treatment the grains were removed from the soil, first washed in 1/1,000 mercuric chloride and then in changes of distilled water and placed individually on agar slopes of maize meal agar. The tubes were now incubated at 20° C., and after fourteen days incubation the number germinated was recorded (a seed was said to have germinated if the main root had emerged from the sheathing coleorhiza). Germination was tested in this experiment on agar slopes so that the types of fungi invading the grains could be investigated; but these particular results of the experiment will be published elsewhere. A series of controls was prepared in which grains taken directly from the original sack were surface washed as in the experimental samples, and placed directly on agar slopes.

The moisture content of the soil was determined by placing weighed samples of maize grains in additional jars of the soil samples, and after twenty-four hours incubation at 20° C. the grains were removed, cleaned with a dry cloth and reweighed. The increase in weight of the grain samples gave a measure of the availability of the soil moisture and is comparable with the method described by Shull for using seeds in the determination of the 'surface forces' of the soil⁴. For the determination of soil moisture, grains of Wisconsin 275 maize

were used, as this variety gave very consistent values. Losses in weight of the grains due to respiration in the twenty-four-hour incubation period were negligible in comparison with the experimental error.

When the treated jars were sampled, it was found that many of the grains had germinated in the soils at high temperatures and moisture contents. The mean percentage germination over all sampling occasions is shown in Fig. 1.

The grains which had not germinated in the jars at the time of sampling were transferred to agar slopes at 20° C. and the subsequent failure to germinate was determined; the mean results over all sampling occasions are given in Fig. 2. Analysis of variance of the results of this experiment show that both time and soil water content have significant effects on the mortality ($P < 0.01$). The effect of temperature as a main effect was not significant. However, the interaction of temperature and soil moisture was highly significant ($P < 0.001$); other interactions were negligible. Clearly, soil moisture is of overriding importance in determining the extent of mortality, and the effect of temperature is mainly to produce an interaction with this main effect. Inspection of Figs. 1 and 2 shows clearly that damage is least where the treatments result in rapid germination. The greatest mortalities are obtained when the temperature and moisture conditions are such that germination just fails to take place. From this pattern of results it is concluded that the pathogens are affected in the same general manner as the host, but are more tolerant in both moisture and temperature requirements.

It is of interest that the two peaks of greatest damage, 8° C. at moisture content IV and 30° C. at moisture content II, were formed at very different rates. At 30° C. maximal damage had been attained by the sixth day; but at 8° C. the degree of injury was small at first but was still increasing after fifteen days. It is probable that the slowing up of the rate of kill is an indication of the rate at which the soil dried. (Determination of the soil moisture content of the soils after fifteen days showed that the soils had lost water during the experiment, but the relative moisture contents of the samples were scarcely changed except where rapid germination had occurred.)

The results of this experiment have an especial significance in a programme of maize breeding in

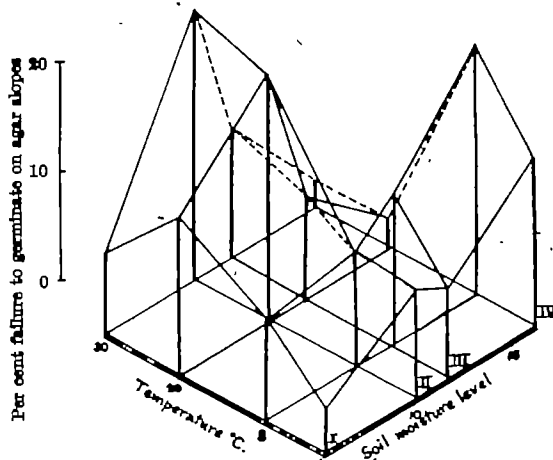


Fig. 2. The influence of various soil moisture and temperature combinations on the viability of maize grains

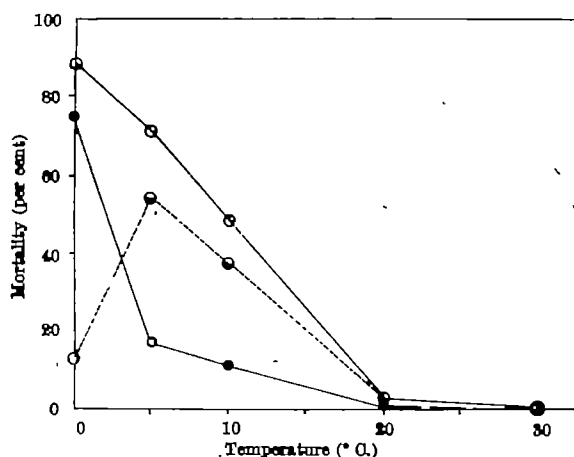


Fig. 3. The influence of fungicide seed dressing on the viability of maize grains exposed to various temperatures in wet soil. ●—●, Treated with fungicide; ○—○, not treated with fungicide; ○—●, reduction in mortality due to fungicide treatment.

which the cold testing of varieties is undertaken. Hitherto little attempt appears to have been made to control the moisture content of the soils employed, and it is our experience that this is the most important single factor which will influence the reaction of the varieties under test. Owing to the grave difficulties involved in maintaining a known and constant soil suction pressure, it is suggested that this cold testing should be undertaken in loosely packed soils, in open-bottomed fibre pots 6 in. tall, which stand in shallow trays of water throughout the experimental period.

In a further experiment a wide range of temperatures was employed, while, in addition, the effects of seed dressing with a commercial preparation of tetramethyl thiuram disulphide were included. The soil water content was maintained by the method previously described. Samples of White Horse-tooth maize grains with and without previous seed dressing were sown in open-bottomed pots of soil standing in trays of water $\frac{1}{2}$ in. deep and incubated at 0°, 5°, 10°, 20° and 30° C. After ten days treatment the pots were all transferred to a temperature of 20° C.; the ultimate germination (inclusive of that during and after treatment) is presented in Fig. 3. It is clear that mortality decreases steadily with a rise in temperature from 0° to 20° C. and that the subsequent rise in temperature to 30° C. has little further effect. The extent of mortality prevented by fungicide dusting increases from 0° to 5° C. and then falls off and becomes negligible at 20° and 30° C. This experiment therefore allows a distinction to be drawn between the damage due to micro-organisms and that which may be called a true cold injury.

These experiments demonstrate clearly that the 'cold test' for maize must be carefully controlled if important and hitherto little-studied variables are to be eliminated. They also make it clear that a cold test of the rigid form used in these experiments could be of the greatest value in assessing the merits of fungicides.

I am grateful to Prof. G. E. Blackman for his interest in this work and his stimulating criticism.

[Dec. 24.]

THE PERIODIC TABLE AND ITS APPLICATIONS

By DR. S. I. TOMKIEFF

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THE fundamental structural pattern of the periodic table of the elements is a network composed of two sets of lines corresponding respectively to periods and groups. This network is the result of the transformation of the linear array of elements, arranged in order of their atomic numbers into a bi-linear combinatorial system, with one set of lines corresponding to cut segments of the original linear array, and the other to similar periodic terms. The points of intersection of the lines of the network correspond to elements, but because of the unequal length of the periods not all these points are occupied. Actual geometrical distances between the nodal points occupied by the elements are of no significance, as we are dealing here with a network in which incidence (position) is the important factor and not congruence (measure). The real metric of the periodic table is the electron-distance. The group lines in each period are separated by one electron-distance, the consecutive period lines by one 'core-electron number' distance.

The fact that the periodic table is a topological combinatorial system, based on incidence, means that it can be distorted or projectively transformed as long as the collinearity of points and the concurrence of lines remain invariant. In this way we can have many types of the periodic table, all projectively related among themselves and all topologically equivalent. The usefulness of any given form of the periodic table depends on its degree of conformity to certain requirements. It should demonstrate the periodicity of the structure and the properties of the elements, it should be continuous, it should be completely visible and it should mirror the structure of the atom. The three principal types of the periodic table satisfying all or some of these requirements are: (1) rectilinear (Newlands, 1864; Mendeleeff, 1869), (2) helical (Béguyer de Chancourtois, 1862) and (3) spiral (Baumhauer, 1870).

Periodicity is possessed by all these three types; but type 1 lacks continuity, while type 2 lacks perfect visibility. Type 3, the spiral periodic table, clearly possesses the first three requirements and it will later be shown to possess the fourth. It is also admirably suited for service as a co-ordinate network for the purpose of contour mapping, and the main purpose of this article is to demonstrate this particular fact.

The periodic spiral used in this article is a modification of B. K. Emerson's "Helix Chemica" (1911). This shows clearly the contrast between the short and the long periods. In its present modification geochemically important elements—carbon and silicon—are placed in a central position.

The method of mapping over the periodic spiral used as a co-ordinate net is the normal cartographic method for contour maps, the data being any kind of numerical values associated with the elements. These data may be grouped under three heads: (1) properties of elements; (2) properties of compounds; and (3) composition of aggregate bodies. Such a geometrization of tabular values offers many advantages. These maps allow us to survey the distribution of the values of any measurable single

¹ Bunting, M. S., and Blackman, G. E., *J. Agric. Sci.*, **41**, 271 (1951).

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³ Dickson, J. G., *J. Agric. Res.*, **23** (II), 837 (1923).

⁴ Shull, C. A., *Bot. Gaz.*, **63**, 1 (1916).

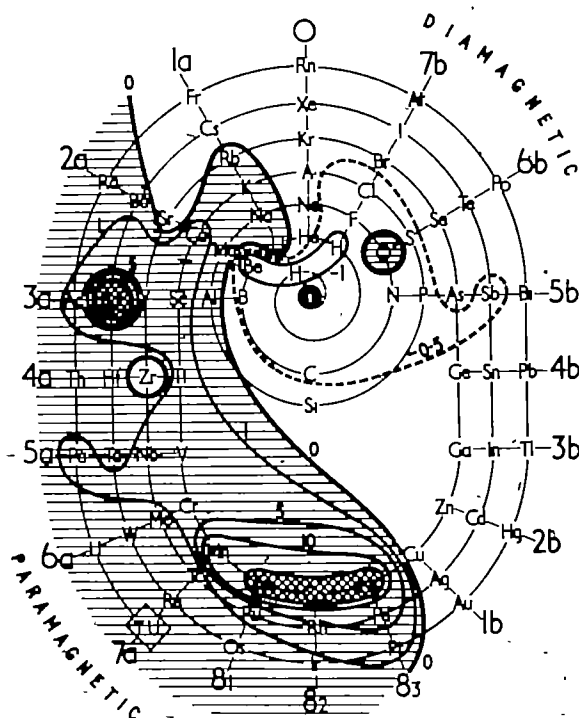


Fig. 1. Map of the magnetic susceptibility surface

property among the elements, to correlate properties among themselves and with the structure of the atom, and finally, to study the composition of aggregate bodies and to compare these with one another.

In what follows I have tried to show briefly some of the possible uses of the three principal types of maps.

(1) Properties of Elements

Maps of surfaces representing the distribution among the elements of such properties as electro-negativity, ionization energy, specific gravity, atomic volume, melting point, boiling point and atomic and ionic radii are to be published elsewhere. So, for the purpose of illustrating the method of cartography, I have selected the map of magnetic susceptibility. The data for the construction of this surface have been obtained from Prof. L. F. Bates's "Modern Magnetism", and all figures refer to measurements taken at or near normal temperature. Describing these surfaces, I will use freely geographical analogies as being generally understood.

The map of the magnetic susceptibility surface (Fig. 1) shows that, with two exceptions (zirconium and oxygen), all the elements are localized within two distinct and separate areas, namely, the paramagnetic 'highlands' and the diamagnetic 'lowlands'. Zirconium forms a 'tarn' in the 'highlands', while oxygen forms a considerable 'peak' in the 'lowlands'. On the other hand, the ferromagnetic elements—gadolinium, iron, cobalt and nickel—form 'peaks' in the 'highlands'. With the exception of the elements of groups 1a and 2a and aluminium and zirconium, all the paramagnetic elements are confined to the region occupied by the elements belonging to the 'transition series' of the long periods (groups 3a to 8a), namely, those elements which in their structure are characterized by the *d*-level electrons.

(2) Properties of Compounds

Numerical data relating to compounds can be mapped over the periodic spiral only in the case of compounds possessing a common component (element or radical). Thus, we can map properties of such compounds as simple oxides, simple carbonates, simple sulphates, and such like, by using the metallic components of these compounds as the index elements of the periodic spiral.

As examples of surfaces showing the distribution of a given property among the compounds, I have chosen the distribution of the heat of formation among simple oxides. The data for the construction of this surface have been obtained from "The Thermochemistry of the Chemical Substances" (1936) by Bichovsky and Roessini. The heat of formation of compounds is usually given per gram-molecule. As the oxides have a great variety of type of molecules, for the purpose of uniformity the heat of formation has been recalculated by me as 'per double bond' of oxygen atom, in calories.

The contour map (Fig. 2) was constructed on the data related to pure compounds. The surface of heat of formation is characterized by a north-west high region, from which stretches a long west-east ridge, occupied by such minerals as corundum (Al_2O_3), rutile (TiO_2), quartz (SiO_2) and cassiterite (SnO_2).

If we take another group of minerals, such as sulphides, for example, we shall see that the heat of formation surface has a shape similar to the heat of formation surface of the oxides, but that the characteristic ridge is half the height of the characteristic ridge of oxides and is also displaced to the 5a-3b line of the periodic spiral.

Like solubility, melting point or hardness, the heat of formation of compounds may be taken as the index of strength. It is interesting, therefore, especially for a mineralogist or geochemist, to obtain such surfaces for various groups of minerals, so as to be

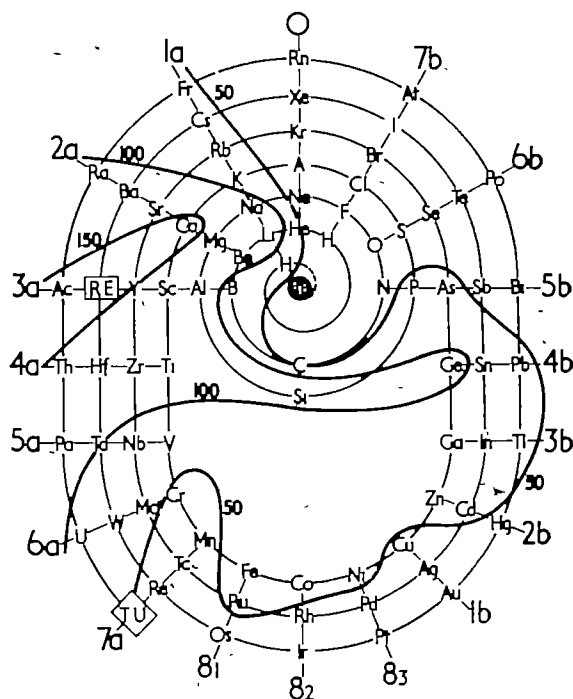


Fig. 2. Map of the 'heat of formation of oxides' surface

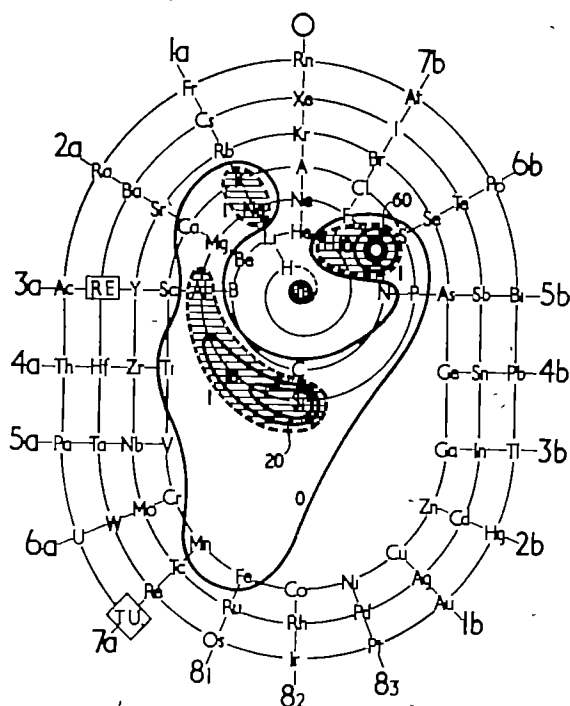


Fig. 3. Map of the 'average composition of granite' surface.
Contours: 0—(1)—10—80.
Leading elements (in atomic percentages): O, 63; Si, 24; Al, 4;
Na, 2½; H, 2; K, 2

able to evaluate their relative strength as influencing their position in the paragenetic succession. As compared with the heat of formation surfaces, the hardness surfaces are somewhat of analogous shape. Thus the hardness surfaces are characterized by dominant ridges like the heat of formation surfaces. The ridge of the hardness surface of oxides, for example, stretches from corundum (Al_2O_3) via quartz (SiO_2) to cassiterite (SnO_2), while in the case of the hardness surface of sulphides the ridge stretches from laurite (RuS_2) via pyrite (FeS_2) to zinc blende (ZnS).

(3) Composition of Aggregate Bodies

In this case it is not the parameters or numerical values of properties that are mapped, but the percentages (weight, volume or atomic percentages) of elements contained in various bodies, such as organisms, rocks, geospheres, meteorites or even the cosmos. An example of such a surface is that of the average composition of granite.

The 'granite' surface (Fig. 3) is in the form of a broken crater-rim, somewhat distorted by the pulling out of the spiral which forms its co-ordinate net. If we use the evenly coiled Archimedean spiral as the basis of the projection, the broken crater-rim or atoll analogy becomes much clearer. Placed on this crater-rim we have three hills, each corresponding to a pair of the leading elements: oxygen-hydrogen hill, silicon-aluminium hill and sodium-potassium hill with magnesium-calcium extension. Such a grouping is most significant from a geochemical point of view, mainly because it reflects the leptological structure of alkali feldspar, the major constituent of granite. The three hills correspond to the three principal structural units of feldspar, namely, (1) oxygen tetrahedra, with (2) silicon-aluminium cores, and (3) sodium and potassium atoms filling up the

'holes' between the oxygen tetrahedra. The other constituent mineral of granite is mica and quartz. Muscovite mica is made of the same elements as potash feldspar with the addition of the hydroxyl group (OH), and quartz is made of interlinked oxygen tetrahedra alone. Oxygen tetrahedra also form the principal structural units of other silicate minerals. In this way the whole of the lithosphere may be visualized as an aggregate of oxygen tetrahedra, with silicon and aluminium forming their cores and sodium, potassium, calcium, magnesium and iron occupying cavities between them.

In the course of this article reference has been made to a supposed relationship between the periodic table of the elements and their atomic structure. One of the qualities of the spiral periodic table—and one, moreover, which is peculiar to the spiral—is that it is not only a periodic table of the elements but also a symbolic representation—a mirror or a map—of the electronic structure of the atom. This contention may be challenged, but it becomes quite clear if we visualize the three-dimensional atom with its nucleus and its concentric electronic shells as represented in a plane by a central blob for the nucleus and concentric circles for electronic shells. A spiral can easily be formed from these concentric circles by traversing them by a radial line and displacing one out edge and of each circle one unit distance to the next circle. Place the appropriate number of points along the coils of this spiral, the number corresponding to the saturation number of electrons in successive numbers of electronic shells—2, 8, 8, 18, 18, 32, . . .—and we have the model of the atom in the spiral, which is at the same time a periodic table with the length of each period expressed in terms of the number of elements in it, as determined by the Tomkeieff¹ formula:

$$X = \frac{(2n + 3 + (-1)^n)}{8},$$

in which X is the length of the period in terms of the number of elements present in it and n is the principal quantum number of the outer shell of the atoms belonging to this period. The periodic spiral thus mirrors the electronic structure of the atom. This means that whatever data relating to the elements we plot over the periodic spiral by using it as a co-ordinate net, we place directly in a functional relation with the atomic structure the two sets of co-ordinates representing (1) period lines of the elements or the core types of the atomic structure, and (2) the group lines of the elements or the periphery types of the atomic structure².

The maps of the surfaces given and discussed in this article represent a small sample of the cartographical method in which data relating to chemical elements are used for the construction of contours over the periodic spiral used as a co-ordinate net. The surfaces thus constructed do not depend on hypothetical presuppositions but represent true correlation between sets of observed numerical data and the periodic table, and as the periodic table in its turn mirrors the electronic structure of the atom, the correlation is between the observed numerical data and the structure of the atom. The surfaces are true invariants of Nature.

¹ Tomkeieff, M. V., *Nature*, 167, 954 (1951).

² Tomkeieff, S. L., "A New Periodic Table of the Elements, based on the Structure of the Atom" (London: Chapman and Hall, 1954).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Pile Production of Radioisotopes by Threshold Reactions

A GREAT advantage of production of radioisotopes by threshold reactions (n,p) and (n,α) , relative to neutron capture (n,γ) , is that the radioisotope can be separated chemically from the target material, and hence be obtained in high specific activity, in principle completely carrier-free. The rate of threshold reactions in the pile, however, is much smaller in general than that of capture reactions, not only because of the low cross-sections for neutrons in the MeV. range but also because of the low flux of neutrons of that energy in the pile. As measurement of the small yields of such reactions is often difficult, especially for long-lived radioisotopes, it is very useful to be able to predict approximate yields in advance. An example is furnished by the reaction $^{54}\text{Fe}(n,p)^{54}\text{Mn}$, recently discussed by Stafford and Stein¹; in this case some experiments had indicated production of the 324-day manganese-54 by pile neutrons, whereas others showed none. The most recent experiments², however, utilizing samples enriched in iron-54, definitely established the reaction with a cross-section for fast neutrons of 11 millibarns (10^{-27} cm.²). It is the purpose of the present communication to point out that the approximate yields for threshold reactions in the pile can be predicted, and to illustrate the method for $^{54}\text{Fe}(n,p)^{54}\text{Mn}$ as an example.

A systematic survey of threshold reaction cross-sections for fission neutrons was carried out by Hughes, Spatz and Goldstein³ in 1946. Whereas the original purpose of the measurements was to investigate the shape of the fission neutron spectrum at high energies, the present well-known spectrum⁴ allows the results to be used to systematize the reaction yields. It is found⁴ that the threshold reaction cross-section for fission neutrons is proportional to the integral of the fission spectrum above an 'effective energy', E_{eff} , which is a few MeV. higher than the threshold energy for the reaction, E_T . The quantity $E_{\text{eff}} - E_T$, which rises rapidly with atomic number, is simply related to the penetrability of the outgoing particle and the fission spectrum shape. Results for (n,p) reactions only are given in Fig. 1, where the cross-sections, multiplied by $10/A^{1/3}$ to correct for variation in nuclear size, are plotted against E_{eff} and compared with the integral of the fission spectrum (solid line). The average deviation of the experimental points from the curve is about a factor of two, although the cross-sections themselves cover a range of 3,000-fold. The results of Fig. 1 indicate that the cross-section for the (n,p) reaction for a neutron energy at which the penetrability becomes unity is approximately proportional to πR^2 (with R the nuclear radius), actually being about $0.1 \pi R^2$, as compared to $0.2 \pi R^2$ for (n,α) reactions⁴.

For the $^{54}\text{Fe}(n,p)$ reaction, E_T is given by the mass difference manganese-54 - iron-54* (0.71 MeV.) minus the $n-p$ mass difference (0.78 MeV.), or -0.07 MeV. The quantity E_{eff} for this reaction is then found to be 4.2 MeV., and $\sigma 10/A^{1/3}$ is obtained from Fig. 1 as 7 mb. The cross-section itself is 9.5 mb. ($A^{1/3} = 13.5$), in surprisingly good agreement with the 11 mb.

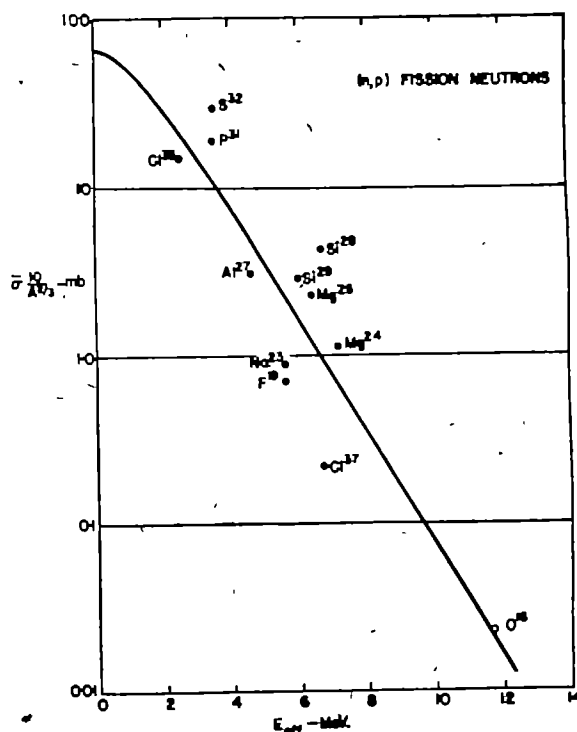


Fig. 1. Measured cross-sections of (n,p) reactions for fission neutrons as a function of effective energy compared with the integral of the fission neutron energy spectrum

measured by Stafford and Stein¹. Although Fig. 1 refers to cross-sections for unmoderated fission neutrons, the cross-sections for pile neutrons as well are principally a result of unmoderated fission neutrons, for which the flux near a uranium fuel rod is approximately equal to the thermal flux⁴. It is interesting that the curve of Fig. 1 works well for the iron-54 reaction even though the experimental points used to normalize it were all for lighter elements.

The practical value of Fig. 1 and the corresponding curve for (n,α) reactions arises from the fact that approximate yield predictions can be made and thus complex and lengthy measurements avoided. The cross-sections will, of course, decrease rapidly for higher values of Z ; for example, for E_T near zero, the cross-sections for (n,α) and (n,p) reactions decrease from 16 and 80 mb. respectively at $Z = 10$, to 0.01 and 1.5 mb. at $Z = 40$. Large variations in E_T occur for light elements, but these become smaller, and affect the cross-sections less, as Z increases.

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¹ Stafford, G. H., and Stein, L. H., *Nature*, 172, 1103 (1953).

² Hughes, Spatz and Goldstein (unpublished, see ref. 4).

³ Bonner, Ferrel and Rinehart, *Phys. Rev.*, 87, 1032 (1952). Hill, D. L., *Phys. Rev.*, 87, 1034 (1952). Watt, B. M., *Phys. Rev.*, 87, 1037 (1952).

⁴ The measurements, as well as the details of their interpretation, are described by the author in "Pile Neutron Research", 93 (Addison-Wesley, 1953).

⁵ Collins, Eler and Johnson, *Phys. Rev.*, 86, 408 (1953).

⁶ Ref. 4, pp. 60, 106.

Tidal Forces and the Formation of Hurricanes

MAY I raise the following question: "Do tidal forces affect the formation of hurricanes?" If one examines the changing direction of the tidal force due to the sun and a moon, near new (or full) on an August day, say, as this force acts on a small element of air located at a point south of the sub-solar latitude and north of the equator, one finds the tidal force would tend to make the atmospheric element move in a counter-clockwise direction as viewed from above. Furthermore, as the sun moves southward in August and early September, the latitudes where the highest atmospheric tides would be expected (here considered semi-diurnal), would fall alternately north and south of the equator, the successive points on either side approaching the equator. Might there not be one time at which the separation of these two latitudes would correspond to a natural frequency of oscillation of the atmosphere? If these arguments have any validity, the hurricanes in the North Atlantic should show an increase in number shortly before September 23 and a decrease shortly after that date.

The first date given for each tropical storm in the years 1900-49 inclusive was taken from Tannehill's "Hurricanes" (eighth revised edition, Princeton University Press, 1952) and the frequencies noted for a number of intervals in the hurricane season. The results are shown in Table 1.

Table 1

Interval	Number	Number per week
August 24-31	32	23
September 1-7	27	27
September 8-14	40	40
September 15-23	33	28
September 23-30	20	17.5
October 1-7	27	27
October 8-14	26	26

To determine whether the change from 40 for September 8-14 to 17.5 (per week) for September 23-30 was statistically significant, the fifty-year period was broken into five ten-year blocks and averages and variances determined. It was found that the change corresponded to a 2 per cent level of significance, that is, that this might happen by chance once in fifty times.

Also, if tidal forces play an important part in the formation of hurricanes, they should leave their mark on year-by-year statistics. Here I elected to break up the eighteen-year interval into four periods of four, five, four and five years. Then the number of hurricanes in each four-year period was increased by 25 per cent so that the comparison might be made on a uniform five-year basis. The results, again based on Tannehill, are shown in Table 2.

Table 2

Interval	Number	Number per 5 years
1900-1906	24	30
1906-1910	35	35
1911-1914	16	20
1915-1919	28	28
1920-1923	19	23.8
1924-1928	34	34
1929-1932	22	27.5
1933-1937	61	61
1938-1941	27	33.8
1942-1946	44	44

The average (on a five-year basis) for the four-year intervals was 27.2 ($\sigma = 4.8$). For the five-year intervals, the average was 40.4 ($\sigma = 11.5$).

I am aware that the tidal forces are not large; but I would suggest that in meteorology the result is not always proportional to the force that triggers the action. I suggest that an investigation of atmospheric tides and their effects on the formation of hurricanes would be worth while.

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Irradiation of Transistors

THE effect of stored holes in transistors has been reported by Meacham and Michaels¹, and the importance of the effect in the design of switching circuits was stressed by speakers in the discussion following a paper by Williams and Chaplin². Briefly, good circuit design often necessitates operating a transistor in the condition where the collector current is limited by an external resistance; in this condition the time of fall of collector current upon cessation of emitter current is found to be much slower than when the collector current is limited only by the current gain of the transistor. It is the time of fall of collector current which determines the maximum switching speed of a transistor.

During some irradiation experiments on commercial point-type transistors in the Harwell pile, we have found that if a transistor is given a radiation dose of about 10^{14} neutrons/sq. cm., the time of fall of collector current from the value limited as described above is decreased, with little or no deterioration of the other parameters of the transistor. Curves of collector current against time after the sudden cessation of an emitter current of 3 m.amp. are shown in Fig. 1 for the same transistor before irradiation and 2 hr. afterwards. The transistor used had a current gain of 2.2, so that at least 6.6 m.amp. of collector current was available; the collector current was limited to about 5.4 m.amp. by an external resistance.

Measurements have been repeated at intervals over a period of four weeks from the time of irradiation and have shown little change. Measurements after

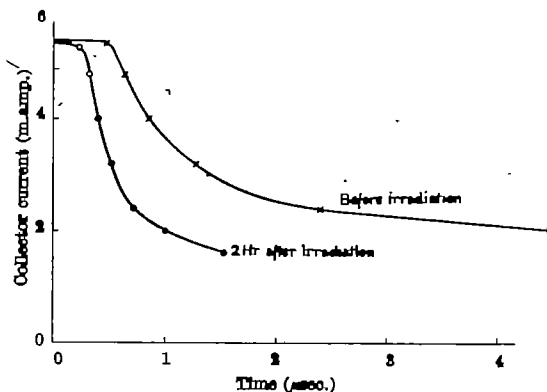


Fig. 1. Fall of collector current following cessation of emitter current

150 cycles of temperature from ambient to 70° C. have also indicated that the change in time of fall of collector current due to irradiation should be permanent.

A sample of mono-crystalline germanium has also been irradiated with a dose of 10^{14} neutrons/sq. cm. A rise in resistivity from 2.03 ohm cm. to 2.24 ohm cm. and a decrease in hole life-time, measured by a modified light-spot system³, from 1.6 μ sec. to 0.6 μ sec. were observed, with little change in hole mobility. In addition, two samples of 6 ohm cm. material have been measured by the Post Office Research Station, Dollis Hill. Decreases in hole life-time from 50 μ sec. to 6 μ sec. and from 6 μ sec. to 1 μ sec. have been reported.

The most abundant expected transmutations⁴ are as follows:

		No of atoms produced
$^{76}\text{Ge} (\alpha, \gamma) ^{76}\text{Ge}$	$\xrightarrow{11 \text{ 4 days } \beta^-}$	^{76}Ga
$^{76}\text{Ge} (\alpha, \gamma) ^{76}\text{Ge}$	$\xrightarrow{83 \text{ min. } \beta^-}$	^{76}As
$^{76}\text{Ge} (\alpha, \gamma) ^{76}\text{Ge}$	$\xrightarrow{12 \text{ hr. } \beta^-}$	^{76}As
	$\xrightarrow{40 \text{ hr. } \beta^-}$	^{76}Se
		$1 \times 10^{11}/\text{c.c.}$

These yields of impurities are low compared with those normally present, and no changes with time since irradiation consistent with these half-times have been observed.

We therefore believe that the decreased time of fall of collector current is caused by the production of recombination centres, such as lattice defects, in the bulk material.

These and similar experiments are being continued. We should like to thank the Chief Superintendent, Services Electronics Research Laboratory, for measurement facilities on germanium placed at our disposal.

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¹ Moseham, L. A., and Michaels, S. A., *Phys. Rev.*, **78**, 175 (1960).

² Discussion following paper by Williams, F. C., and Chaplin, G. B. B., *Proc. Inst. Elec. Eng.*, Part III, **100**, 66, p. 245 (1953).

³ Goncher, F. S., *Phys. Rev.*, **81**, 3, 475 (1951).

⁴ Lark-Horovitz, K., "Nuclear-bombarded Semi-Conductors" in "Semi-Conducting Materials" (Butterworths, London, 1951).

A Solid State Transformation in Tetra-acetyl-D-ribofuranose

It has been reported¹ that two modifications of 1,2,3,5-tetra-acetyl-D-ribofuranose can be prepared, one (A) melting at 56–58° C.; the other (B) melting at 85° C. It was also reported that a transformation in the solid state took place from A to B which was catalysed by the presence of B, and that no laboratory which was once contaminated by B had been able to repeat the preparation of A.

In a discussion with Dr. George B. Brown, of the Sloan-Kettering Institute for Cancer Research, New York, N.Y., it was suggested that X-ray data be taken for these two materials, even though a detailed structural analysis might not prove immediately to be feasible.

Several months later, a single crystal suitable for X-ray work was obtained from a sample of the A-material prepared and sent to us by Dr. Irving Goodman, of the Wellcome Research Laboratories, Tuckahoe, N.Y. The X-ray study was carried out by Weissenberg and Buenger precession techniques. There are two molecules in a monoclinic cell of the space group $P2_1$, the dimensions of which are:

$$a = 12.49 \text{ \AA}, b = 5.58 \text{ \AA}, c = 11.12 \text{ \AA}, \beta = 97^\circ 45'.$$

Weissenberg multiple-film photographs for the layers $h0l$, $h1l$, $h2l$ were taken with copper radiation. Precession photographs using copper and molybdenum were taken of the $h0l$, $h1l$, $0kl$ and $1kl$ layers.

The single crystal of the A-material mounted for X-ray examination remained stable for seven weeks. At the end of this period crystals of the B-modification were obtained from Dr. Brown and were also mounted for X-ray examination. The A-crystal remained stable in the same room with the B-crystals for about three days. Some of the B-material was powdered and sprinkled over the A-crystal at the start of a Laue photograph exposure. The resulting film indicated that the A-crystal had transformed completely to the B-material in 5–15 min. The transformed material, a fine powder of the B-substance, formed an opaque block in the external shape of the original A-crystal. It had been hoped that the transformed powder would show some preferred orientation with respect to the original A-structure, but this was not apparent.

Weissenberg and precession photographs of the stable B-material identified the space group as $P2_12_12_1$ with four molecules in a cell of dimensions:

$$a = 7.50 \text{ \AA}, b = 13.66 \text{ \AA}, c = 15.33 \text{ \AA}.$$

No systematic collection of intensity data for the B-material has been undertaken.

It is interesting to note that the molecular volume increased by about two per cent during the transformation (A: 383.9 $\text{\AA}^3$; B: 392.5 $\text{\AA}^3$).

At the present time, we do not contemplate detailed analysis of the data we have obtained. We shall be glad to furnish further information on our results to those who are interested.

It is a pleasure to thank Dr. Brown for his suggestion and discussion of this investigation and for the material which he supplied us. We are also very grateful to Dr. Goodman for the sample of the rare A-material.

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¹ Davoll, J., Brown, G. B., and Vincer, D. W., *Nature*, **170**, 64 (1952).

Static Electrification of Petrols

It is well known that petrols flowing down a tube acquire a quite considerable electrostatic charge, and it is perhaps less well known that the addition of a reasonable quantity of alcohol reduces this charge to insignificant proportions¹. Some recent experiments on the effect of small quantities of alcohol reveal, however, very puzzling results. The pure petrol always acquires a positive charge and the addition of slightly more than 1 per cent of alcohol reduces the charge to zero; but what is remarkable is that the addition of a little more alcohol produces a

negative charge until about 8 per cent, after which the charge is negligible.

This general result is true (though the magnitude of the charges vary) for all the different brands of petrol tested and also for toluene. It is true whether the flow is steady or turbulent, and is unaffected by altering the materials of the tube. In fact, the same thing occurred when the mixture ran through muslin or a filter paper, in both of which cases the charges were far higher than when the mixture was running down a metal tube.

As an example, 20 c.c. of 82 octane aviation spirit run down a Dural tube 40 cm. long and 5 mm. diameter acquired when pure a charge of +1.5 e.s. units; 2 per cent of alcohol reduced this to zero, and from 2 to 8 per cent the charge was negative, rising to a maximum of -22 e.s. units for 4 per cent and thereafter decreasing. Thus the charge is not only reversed but also becomes much larger than for the unadulterated petrol.

The only part of the phenomenon which is readily understandable is the disappearance of the charge for the higher concentrations. The petrol itself has an enormous electrical resistance, but the addition of alcohol much reduces it and the charges acquired by contact with the tube then leak back to it before they can be carried away by the emerging liquid. The specific resistance of the aviation spirit was of the order of 5×10^{12} ohms per cm. cube. The addition of each successive 2 per cent of alcohol reduced the resistance by a factor very close to 10, so that the 8 per cent solution had ten thousand times the conductivity of the spirit.

It would be wise, however, to hesitate before theorizing as to the cause of the reversal of sign of the charge, as the following experiment shows that things are more complex than might appear at first sight.

If a mixture is chosen giving the negative charge, and the same specimen is poured repeatedly down the same tube, the negative charge decreases each time, finally becoming positive and ending up for some concentrations at a value rather higher than the unadulterated petrol produces. This surprising change in the charge is not the result of the mixture altering in any way by evaporation or otherwise, for the resistance remains unaltered.

It would appear, therefore, that the negative charge is not due to the alcohol-petrol mixture, but to minute quantities of some third substance which is removed by the ions transferred in each run down the tube. Whether this third substance is the small amount of water always found in alcohol is uncertain.

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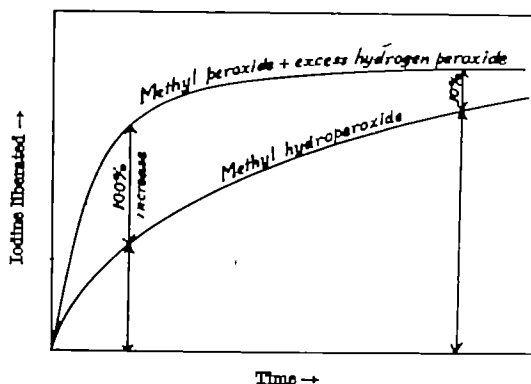
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¹ Hartshorn and Ward, *J. Soc. Chem. Indust.*, 57, 178 (1938).

Effect of Hydrogen Peroxide on the Analysis of Organic Peroxides

In many combustion products, hydrogen peroxide forms a large part of the peroxidic products isolated¹. It is therefore worth recording some observations on the interference caused by hydrogen peroxide in the analysis of such mixtures as hydrogen peroxide and methyl hydroperoxide.

It has long been known² that alkyl hydroperoxides, unlike hydrogen peroxide, do not liberate the stoichiometric



metric quantity of iodine from acidified potassium iodide. It has now been found that the extent to which they react depends, not only on the time, and on the type and amount of catalyst, but also on the concentration of any hydrogen peroxide which is present.

The estimations were carried out in an atmosphere of oxygen-free nitrogen in stoppered flasks in the absence of light. The test solution, containing hydrogen or methyl peroxide, or both, was added to 25 ml. of 2 N hydrochloric acid together with 1 c.c. of 50 per cent potassium iodide. Any catalyst was added at this stage. Nitrogen was again passed, and the flask stoppered. A blank run, free of peroxide, was also carried out. The catalyst, either ammonium molybdate or ferrous sulphate, was added in the form of three drops of a 2 per cent solution. After a given time, the iodine was titrated against 0.01 N sodium thiosulphate. The following results are typical of many others which were obtained.

In the presence of 6.43 ml. of 0.01 N hydrogen peroxide, the iodine liberated by a constant amount (10.4 ml. of 0.01 N) of methyl hydroperoxide was increased by 16 per cent after 1½ hr. by the addition of ferrous sulphate, while ammonium molybdate had practically no effect during this time. However, it was found that, if the concentration of hydrogen peroxide was increased thirty times, the iodine liberation of the methyl hydroperoxide was increased by 57 per cent after 3 hr., and by 28 per cent after 15 hr. It is clear that the indicated concentration of organic peroxide depends both on the ratio $H_2O_2/ROOH$ and on the time, as is shown schematically in Fig. 1. Evidently, the interpretation of iodometric estimations of peroxide mixtures must be made with great caution.

A parallel effect, also dependent on the relative concentrations of the peroxides, has been observed in the reaction of the lower peroxides with potassium permanganate in acid solutions³.

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¹ Everett and Minkoff, *Third Symp. on Combustion*, etc., 390 (Baltimore, 1946). Minkoff and Balooja, *Fuel*, 33, 516 (1953).

² Bloche, "Alkylperoxide" (Leipzig, 1931).

³ Everett and Minkoff, *Anal. Chem. Acts* (in course of publication).

Possible Existence of a Transition Point between β - and γ -Sulphur

γ -SULPHUR, the metastable monoclinic modification first described crystallographically by Muthmann¹, is frequently obtained when a thin film of molten sulphur between a slide and cover slip is caused to solidify by chilling. Using such preparations, we have recently made some preliminary determinations of the linear rates of transformation of this form into both α - (rhombic) sulphur and β -sulphur, the monoclinic modification stable above 96°, as an extension of previous studies of the linear rate of transformation of β - into α -sulphur²⁻⁴. The smoothed results are shown in Fig. 1, which also gives those for the β - to α -transformation. The three curves intersect at A, B and C, and although the temperature co-ordinates given for these points, namely, 12°, 55° and 75° respectively, can only be regarded as approximate at present, their existence is not in any doubt, since they have been confirmed by a number of observations of the relative rates of the transformations on slides on which all three forms were present.

The existence of a point A at which the rates of transformation of β to α and of γ to α are equal raises the interesting question as to whether there is a transition point between β - and γ -sulphur at or near this temperature. This possibility is suggested by the following considerations. In certain theories already put forward to account for the linear rate of polymorphic transformations⁵, the rate may be expressed as a function of the free energy change, the temperature, and the vapour pressure of one of the two modifications. Thus the expression proposed by one of us (N.H.H., *ibid.*, p. 160) may in its simplest form be rewritten as:

$$v_{\beta\alpha} = \text{const. } p_1 [\exp(-\Delta G/RT) - 1], \quad (1)$$

where $v_{\beta\alpha}$ is the rate, p_1 is the vapour pressure of the stable form, and the other symbols have their usual significance. Again, Dunning's equation (*ibid.*, p. 157) may be put in the form:

$$v_{\beta\alpha} = \text{const. } p_1 \cdot \exp(-\Delta G/RT) \cdot \exp[\text{const.}/(\Delta G \cdot RT)]. \quad (2)$$

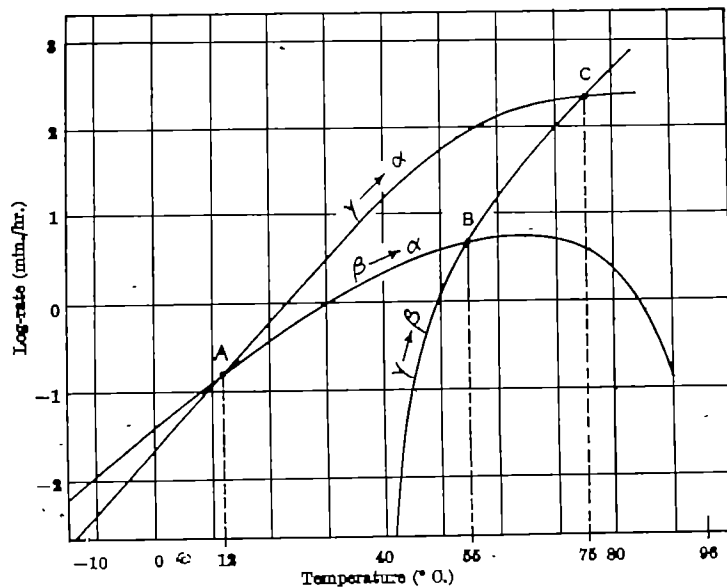


Fig. 1

These alternative forms are obtained by using the relationships:

$$p_1 = \text{const.} \exp(-L_1/RT);$$

$$-\Delta G = q[(T_0 - T)/T_0] = RT \ln(p_{\beta}/p_1),$$

where L_1 is the latent heat of sublimation of the stable form, q is the heat of transformation, T_0 the transition temperature, and p_{β} is the vapour pressure of the unstable form. The constants in (1) and (2) depend only on the properties of the stable form.

On this basis, we have for the β to α and γ to α transformations:

$$v_{\beta\alpha} = F(\Delta G_{\beta\alpha}, T, p_a),$$

$$\text{or} \quad \Delta G_{\beta\alpha} = H(v_{\beta\alpha}, T, p_a), \quad (3)$$

$$\text{and also} \quad \Delta G_{\gamma\alpha} = H(v_{\gamma\alpha}, T, p_a), \quad (4)$$

where F and H signify 'function of'.

The two functions (3) and (4) are of the same form and contain the same constants since the stable form (α) is the same in both cases.

For the γ - to β -transformation, we may write:

$$\Delta G_{\gamma\beta} = J(v_{\gamma\beta}, T, p_p),$$

where J signifies a function which will contain different constants from those in (3) and (4), since the more stable phase is now β .

$$\text{Now} \quad \Delta G_{\gamma\beta} = \Delta G_{\gamma\alpha} - \Delta G_{\beta\alpha};$$

so that if $v_{\gamma\alpha} = v_{\beta\alpha}$, $\Delta G_{\gamma\alpha} = \Delta G_{\beta\alpha}$ and $\Delta G_{\gamma\beta} = 0$, that is, a transition point exists at this temperature between the γ - and β -forms.

This treatment, however, takes no account of adventitious factors such as the mosaic block size of the unstable form or the difference in densities of the two forms, which may affect the rates of transformation of β to α and γ to α to different extents (see, for example, reference 3, p. 1112, for discussion of the possible effect of mosaic block size), so that equality of the rates at a certain temperature does not necessarily mean that the free energies of the β - and γ -forms are the same at this temperature. It does, however, suggest that they may be equal at a temperature near this.

The simplest experimental test of the existence of a $\gamma\beta$ -transition point would appear to be to see whether a reversal in the direction of movement of the $\gamma\beta$ -interface occurs at low temperatures; but this test has failed because at temperatures below 40° no movement whatsoever of this interface can be detected (at least down to -15°, the limit of our observations) even under a high-power microscope over a period of some weeks. The very high temperature coefficient of this transformation at temperatures above 40°, which corresponds to an apparent activation energy of about 150,000 cal. per mole (curve BC below B), however, is just what would be expected if there were a transition point not too far below this temperature. General theoretical considerations based on the fact that above a transition point both molecular motion and 'driving force' (that is, free energy change) increase with rise of temperature, and also experimental observations, for example, on the α - to β -transformation in sulphur above 96°, support this.

The phase transformations in sulphur are markedly accelerated when it is contaminated with carbon disulphide, and in films prepared from such material we have found that the temperature of the $\alpha\beta$ -transition point is not altered within the limits of accuracy (about 2°) of the hot stage used for our observations. This suggests that the carbon disulphide adds another phase as well as another component to the system, and this phase appears to be a liquid layer at the interface, since under the microscope bubbles can be seen moving about in this region as the reaction proceeds. If a $\gamma\beta$ -interface is established in such contaminated sulphur, observable movement at low temperatures now occurs; but at all temperatures down to -18° (the lowest attainable for microscopic observations with our present arrangements) the direction of the transformation is still γ to β . Thus the transition point, if it exists, is probably below this temperature.

Point C (Fig. 1) represents a somewhat similar case to that just discussed, for here the rates of transformation of γ to α and γ to β are equal, and the well-established transition point between the α - and β -forms exists at the not far distant temperature of 96°. The difference from the previous case is that the reactant phase (γ) is the same in the two transformations, whereas at point A it is the resultant phase (α) which is the same.

This work will be described and discussed in more detail in a further publication. It is also intended to attempt determinations of the vapour pressures of the β - and γ -forms down to low temperatures. This should provide conclusive evidence of the existence or otherwise of a transition point between these forms.

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¹ Mühlmann, W., *Z. Krist.*, 17, 236 (1900).

² Elias, P. G., Hartshorne, N. H., and James, J. H. D., *J. Chem. Soc.*, 588 (1940).

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A Rapid Gasometric Method of Analysis for 'Reducing' Sugars and Other Carbonyl Compounds

ANALYSIS for reducing sugars generally involves oxidation under highly disruptive conditions with an alkaline reagent. As a consequence of the oxidative fragmentation of the sugars, the stoichiometry of the reaction is not simple, and it is necessary to employ closely controlled concentration and temperature conditions. The interpretation of the results requires the use of extensive empirical tables. Since the reducing equivalence of the various mono- and di-saccharides is not the same, an additional dimension of uncertainty is introduced into the procedure for the analysis of mixtures of reducing sugars.

Employing aqueous solutions of sodium borohydride for the reduction of 'reducing' sugars to the corresponding polyols, we have been able to carry out the rapid determination of reducing sugars at acidities of pH 7 and higher. Sodium borohydride solution is standardized by measuring the volume

of hydrogen gas evolved when the solution is made acid. The sugar solution is treated with an aliquot of the sodium borohydride reagent, and after completion of the reduction, the excess of reagent is determined by acidification, etc., as in the standardization. The difference in volume of hydrogen evolved is equivalent to the amount of 'reducing' sugar. By collecting the hydrogen over water in a very simple apparatus, we have found that one mole of hydrogen is utilized for the reduction of one mole of glucose, fructose, galactose, lactose or glucosamine with an accuracy of better than 1 per cent. Complete reduction is achieved in 20-30 min. at room temperature, or in less than one minute at the boiling point. Although aqueous sodium borohydride solutions are stable at room temperature, aliquots are most conveniently pipetted at 0° C.

Since this analytical method has many obvious applications in organic, biochemical and clinical analyses, it was considered advisable to make a preliminary report. Detailed results relating to sugar analysis, and analysis for carbonyl compounds and derivatives in general will be published later.

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The Girard Reaction

Girard and Sandulesco¹ developed a method now known as the 'Girard reaction' for the isolation of small amounts of ketosteroids such as the sex hormones from natural products. Aldehydes and ketones in the mixture are converted into water-soluble hydrazone derivatives by treatment with the 'Girard P' or 'T' reagent, and the non-carbonyl compounds are removed by extraction with a non-polar solvent like ether. The ketone complexes are rapidly decomposed with mineral acid; but the aldehyde derivatives are claimed to be stable except in the presence of a large excess of acid and formaldehyde.

Recently, in an investigation of the compounds responsible for the so-called 'cardboard' flavour in skim milk, acetaldehyde was observed in 'ketonic fractions' isolated by these methods.

A study of the literature showed that Girard aldehyde complexes are not as stable as generally believed, for Lederer and Nachmias² were able to decompose some of them with hydrochloric acid after 12-14 hr. at room temperature giving 80-90 per cent yields of heptaldehyde, citral, *m*- and *p*-hydroxybenzaldehyde, 3,4-dihydroxybenzaldehyde and piperonal.

We were interested in saturated and unsaturated aliphatic aldehydes and ketones, and studied the stability of the 'Girard P' complexes of acetaldehyde, crotonaldehyde, propionaldehyde, butyraldehyde, isovaleraldehyde and *n*-heptaldehyde and acetone, methyl ethyl ketone, mesityl oxide and methyl *n*-amyl ketone. In all cases the decomposition of the Girard complex with *N*/2 sulphuric acid was found to be almost instantaneous.

It seems that the Girard reaction, while it often fails to separate aldehydes and ketones, may be suitable for the separation of carbonyl from non-carbonyl

compounds. In many cases the liberated aldehydes and ketones can be extracted as soon as the mineral acid is added.

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Anthocyanins in Bananas

THE inflorescence of the banana bears female flowers at the base and male flowers apically. At each node is a cluster of flowers subtended by a brightly coloured bract, and it is upon the anthocyanins of these bracts that most of the results summarized below are based. The pigments were extracted in 1 per cent hydrochloric acid and examined in the test-tube and by paper chromatography. A picrate which was isolated from one species yielded glucose only on hydrolysis. Definition of the glycosidal types awaits determination of the sugar residues in other purified samples. After hydrolysis, the anthocyanidins were determined by means of chromatography in the Forestal solvent¹ and in butanol-2N hydrochloric acid² used separately, or jointly for a two-way separation.

The anthocyanidins. Six anthocyanidins were found, namely: pelargonidin, cyanidin, peonidin, delphinidin, petunidin and malvidin. Bract colours vary correspondingly from scarlet to deep purple or violet. Specific occurrences were as follows.

(1) Pelargonidin-cyanidin mixture: *Musa coccoinea* (one clone examined).

(2) Cyanidin-delphinidin mixtures: *M. lateralis* (one clone), *M. balbisiana* (ten clones), *M. velutina* (one clone).

(3) Partly methylated cyanidin-delphinidin mixtures (that is, mixtures of cyanidin, peonidin, delphinidin, petunidin and malvidin in various proportions): *M. acuminata* (twelve clones).

(4) Methylated cyanidin and delphinidin (peonidin and malvidin in various proportions): *M. ornata* (one clone), *M. violascens* (one clone) and an undescribed species from Assam (two clones).

Several anthoxanthins are present and their occurrences also show signs of being related to taxonomy.

Special interest centres on *M. acuminata* as the most variable species and the most important from the point of view of origins of edible bananas³. Two-way chromatograms of the anthocyanidins of eleven clones were made, and each paper was scored by two independent observers for relative intensity of the various pigments; the whole series was repeated and the results for one pigment (malvidin—more or less arbitrarily selected) were analysed, thus:

Item	D.F.	M.S.	V.R.	P
Clones	10	79.31	69.5	0.1 per cent
Replicates	1	6.57	5.76	5 per cent
Observers	1	5.12	4.49	—
Clones × replicates	10	3.77	3.30	5 per cent
Clones × observers	10	0.71	—	—
Replicates × observers	1	1.64	—	—
Error	10	1.14	—	—

There are real differences between clones, though the clones × replicates interaction shows that the

proportion of malvidin varied slightly as between samplings. There is excellent agreement between the scorings of the two observers. Thus, it may be suggested that the anthocyanidins could be estimated by measurement of optical density of the spots.

The clones of *M. acuminata* which were used came from various parts of the Far East between Java and Burma; between these extremes there is a cline of bract colour from red in the south to dull purple in the north. This cline is an expression of changing proportions of the anthocyanidins (Fig. 1); delphinidin increases to northward and, simultaneously, the degree of methylation also increases. Probably delphinidin derivatives have increased under natural selection for blueness and methylation has followed under natural selection for stability.

Edible bananas have, broadly speaking, the pigments expected on taxonomic grounds. Thus, cultivated varieties of *M. acuminata* have (with one interesting exception) partly methylated mixtures of cyanidin and delphinidin, and varieties allied to, but not necessarily wholly derived from, *M. balbisiana* have no methylation.

Ontogeny of pigmentation. The male bud of the banana is composed of a short flower-bearing axis covered with tightly imbricate bracts. The outside bracts are the oldest and are fully coloured; successively younger bracts are smaller and paler and at about bract number 9 colour disappears. Now this bract series represents an ontogenetic sequence, and it is therefore possible to follow the development of pigmentation from inception to maturity. The photograph (Fig. 2) shows the results of one experiment; the white bracts on the right contained leucocyanidin and leucodelphinidin; as visible colour appeared so methylated pigments also appeared, and at maturity the anthocyanins were glycosides of peonidin, malvidin, cyanidin and delphinidin. It is not possible here to determine with certainty the relative contributions of the products of hydrolysis of unmethylated leuco-substances and aglycones of the corresponding visible pigments. However, judging by the comparative intensities of the various anthocyanin and anthocyanidin spots, the leuco-substances (as revealed by this method of extraction) had almost disappeared from the mature

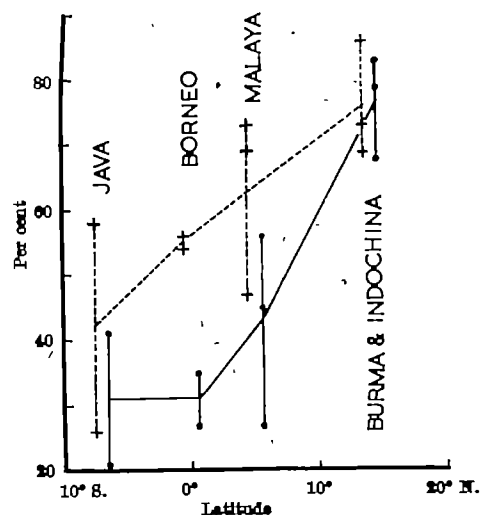


Fig. 1. Geographical distribution of anthocyanidins in bracts of *Musa acuminata*. Solid lines, proportion of delphinidin derivatives; dotted lines, proportion of pigments methylated.

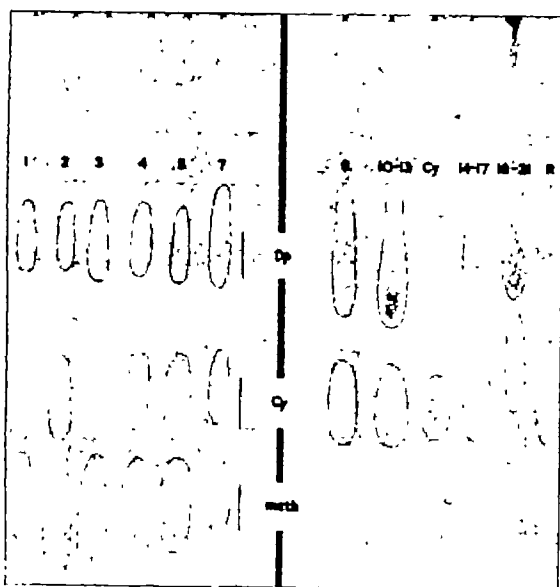


Fig. 2. Ontogeny of anthocyanidins in a male bud of *Musa sapientum*, clone Langot A. Mature bract (No. 1) on the left, Nos. 2-7 successively younger and more lightly pigmented; on the right, immature colourless bracts containing leucocyanidin (cyanidin marker, cy) and leucodelphinidin. 'Meth', methylated pigments, malvidin appearing first, peonidin later but more abundantly.

bract. Malvidin appeared several days before peonidin, when the two, as in this experiment, were present together. This can be seen in the photograph and was proved in another experiment by two-way chromatography.

The elegant seriation of the male bud, the relatively large size of the bracts and the difference in times of appearance of different pigments all combine to indicate this as very favourable material for investigating the biosynthesis of the anthocyanins. Both the search for possible precursors⁴ and the experimental approach, of supplying synthetic precursors to genetically acyanic varieties, would be feasible. Furthermore, the possibility of being able to approach the problem of methylation is particularly attractive⁵.

Leucocyanocyanidins. Leucodelphinidin⁶ and leucocyanidin are almost universally present in bracts, flowers, fruits, sheaths and leaves of all bananas. They are especially abundant in green fruits; the great quantities of this material available at once suggest bananas as an excellent source for structural and biochemical investigations, since quantities of the order of 5 kgm. of dried material could quite easily be obtained.

A fuller account of this work will be published elsewhere. My thanks are due to Dr. E. C. Bate-Smith, Dr. W. G. C. Forsyth and Mr. K. De Witt for much help.

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An Inhibitor of the Lysis of *Staphylococcus aureus* by Bacteriophage

UNDILUTED phage lysates of certain strains of *Staph. aureus* (type 75B) but not of others (type 69) have been shown by us to inhibit the propagation of a wide range of staphylococcal phages¹. To throw light on the nature of this inhibitor we have carried out the following experiments.

Fresh lysates were produced by plate propagation of phage 75B on *Staph. aureus* PS75B, as described by Williams and Rippon², and filtered through 'Gradocol' membranes of pore diameter 55 μ , 83 μ and 140 μ . The filtrates were spotted on a plate freshly inoculated with phage and *Staph. aureus* 31A as for propagation. After incubation the plates showed diffuse lysis, with disks of staphylococcal growth at the sites inoculated with filtrate from the membranes of 83 μ and 140 μ pore diameter, but not at the sites where filtrate through pore diameter 55 μ had been inoculated. Lytic phage was present in filtrates from the 83 μ and 140 μ membranes, but none was found in the filtrate from the 55 μ membrane. The inhibitor was therefore carried on particles of the same order of size as the phage particles.

We next compared the heat sensitivity of lytic and inhibitory components of the phage 75B lysate. 1-ml. amounts of the lysate were heated for 10 min. at 42°, 47° and 52° C., samples being taken at 1-min. intervals, and tested for inhibition and lysis. We found that the inhibitor was destroyed after 2 min. at 52° C., but was unaffected after 10 min. at 42° C. and 47° C. Plaque counts from the same samples titrated for viable phage showed that no significant reduction in lytic power occurred after 10 min. at 52° C.

These experiments suggest that the phage inhibitor may be carried on phage particles, but that the properties of lysis and inhibition can be dissociated by heat, the former persisting at temperatures which destroy the latter.

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Effect of Nickel Versenate on Oat Plants

IRON versenate is now being widely used for supplying iron in plant nutrition studies¹, and it seems likely that the use of versenates of essential micro-nutrients will be extended to horticultural and agricultural practice. Ferric potassium versenate has been used here for two years as a source of iron for oats, sugar beet and tomatoes, and has proved superior to ferric citrate, especially where the pH of the nutrient solution is greater than 6.0. It is not clear whether the complex molecule itself is absorbed or whether the iron is removed at the root surface by a contact-exchange mechanism, as has been suggested by some workers².

Nickel toxicity studies carried out in this department, following the discovery of several naturally occurring nickel-toxic soils in Aberdeenshire, have established that 2.5 p.p.m. nickel (as sulphate) in the

nutrient solution will produce marked necrosis in oats grown in sand culture. The form of iron supplied (versenate or citrate) has no effect on the intensity of the toxic symptoms, although an increase in iron-level reduces necrosis³.

Soil studies had indicated that much of the nickel in a peaty nickel-toxic soil is present in chelate form, associated with the soil organic matter, and that this nickel is readily available to plants. It was therefore decided to investigate the effect of a chelate form of nickel on oats in sand culture.

Nickel versenate (1 mol. nickel to 1.5 mol. ethylenediamine tetra-acetic acid) was supplied at a level equivalent to 2.5 p.p.m. ionic nickel in the nutrient solution. Iron was given either as versenate or citrate at 1.2 p.p.m., and plants received nutrient solution in adequate amounts twice daily from germination.

Ionic nickel produced characteristic longitudinal white striping of the oat leaves, which first appeared when plants were 5 cm. high. The plants supplied with nickel versenate were still a healthy green when the experiment was sampled at the end of thirty-five days. Plants were dried and major elements, nickel and iron, determined in the dry matter after ashing. Variation in treatment produced no significant differences in content of major elements. Average values for yield and nickel and iron contents of the two pots in each treatment are set out in the accompanying table.

	Fresh yield per pot (gm.)	p.p.m. Metal in dry matter	
		Iron	Nickel
<i>Ferric citrate series</i>			
Control	65.5	100	11.3
2.5 p.p.m. Ni^{++}	56.5	104	12.4
2.5 p.p.m. Ni as versenate	73.9	91	9.7
<i>Iron versenate series</i>			
Control	67.6	107	8.4
2.5 p.p.m. Ni^{++}	57.7	105	100
2.5 p.p.m. Ni as versenate	64.7	91	14.5

Since the level of nickel in plants supplied with nickel versenate did not vary significantly from that of the controls, whereas in plants receiving ionic nickel at the same concentration the level was more than ten times as great, the inference is that no absorption of the nickel complex occurred. For the same reason, it would appear that the plants were unable to remove nickel from the complex at the root surface, although this may well have been the mechanism operative in the case of iron.

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Rate of Milk Secretion in Dairy Cattle in the Intervals between Consecutive Milking

With dairy cows milked by the normal methods, a proportion of the milk is not removed from the secretory tissues of the udder. This residual milk may be up to 20 per cent of the milk and contain 50 per cent of the fat present in the udder at the start of milking¹. The amount left is proportional to the milk yield².

Early experiments designed to determine the rate of secretion of milk did not allow for variations in

the amount of this residual milk, and it was assumed that the yield of milk obtained at a milking was a true measure of the amount secreted since the last milking. These experiments^{3,4} indicated that the rate of secretion of milk and fat is inversely proportional to the time since the last milking, and that the rate of formation of the milk fat declines more quickly than the non-fatty fraction. The importance of residual milk in experiments on rate of secretion has been pointed out by Turner⁵, who, after correcting for these effects, suggests that rate of milk secretion does not decline for twenty hours after the last milking. Using an experimental method designed to eliminate residual milk effects, it has been shown at this Institute that the rate of formation of milk and fat both decline with increasing interval since the last milking, and the fall in the rate of secretion of fat is not greater than that of the milk.

Experimental method. In order to eliminate the effect of residual milk the following experimental method was adopted. Five cows were milked at intervals of 3, 6, 9, 12, 15 and 18 hr., the order of milking being as follows: 12 (6), 9 (5), 15 (5), 6 (8), 18 (5), 3 (24), 18 (6), 6 (10), 15 (8), 9 (7), and 12 (6). The figures in brackets indicate the number of consecutive milkings carried out for each interval. This method differed from that of the earlier workers in that five or more consecutive milkings were carried out for each of the milking intervals.

Results. The individual milk-yields in each series of milkings were similar, and it follows that the amounts of residual milk left after each milking in a series were also similar. Therefore, the milk obtained at each of these milkings can be regarded as the quantity secreted in the previous milking interval, provided that the initial milkings after each change-over are not considered.

Fig. 1 illustrates the average amount of milk secreted after the various intervals and the fat percentages of the milk calculated from the results for the five cows. In the case of the graph of fat percentage, the results are shown in two ways. Curve B is the graph obtained by using a mean of the consecu-

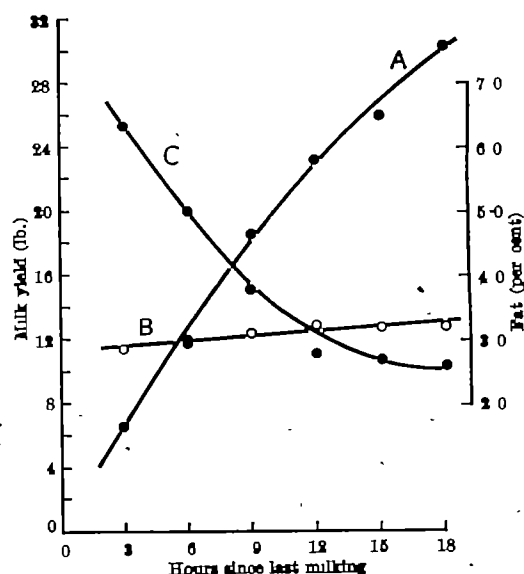


Fig. 1. The mean yield (A) and fat percentage (B) of the milk secreted by five cows in the first 18 hr. after the last milking; (C) shows the fat percentage of the milk obtained when no attempt is made to standardize the previous milking interval.

tive milkings disregarding at least the first two readings after change-over, and curve *C* is obtained when only the first reading after each change-over is used. The results used in the latter graph are those influenced by residual milk effects, and they have been calculated by a method which approximates to that used by earlier workers^{3,4}.

From curves *A* and *B* it will be seen that the true rate of secretion of both milk and fat declines with increasing interval since the last milking. The milk-yield result is in agreement with Ragsdale *et al.*³ and Johansson⁴, but not Turner⁵. Curve *B* illustrates that the rate of decline of the fat secretion is not greater than the decline in milk secretion. In fact, the reverse is probably true, because the mean fat percentages of the milk secreted in 3, 6, 9, 12, 15 and 18 hr. are 2.86, 3.02, 3.19, 3.17, 3.20 and 3.24 per cent respectively. The results illustrated by curve *C* are influenced by residual milk and show a similar trend to those of Ragsdale *et al.*³ and Johansson⁴.

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Low Niacin Concentration in the Breast Milk of Bantu Mothers on a High-Maize Diet

GOLDSMITH and co-workers¹ prepared wheat and maize diets containing equal, though relatively small, amounts of niacin and tryptophan, 4.7 and 190 mgm. per diam respectively; when fed to human subjects, only those consuming the maize diet developed pellagra. In view of this abnormality of metabolism on the maize diet, it has been considered worth while to investigate whether a diet containing this cereal causes any abnormality in the concentrations of niacin and tryptophan in breast milk. Available information suggests that the level of niacin in the breast milk of White mothers is relatively independent of dietary intake². In South Africa, however, Kropman³ found twelve Bantu breast milks to contain an average of 108 μ gm. niacin per 100 ml.; this average is low in comparison with the mean value of 183 μ gm. obtained for the milks of 288 American mothers⁴. Kropman³, unfortunately, provided no dietary information on the mothers concerned—an important point in the present issue, since the consumption of maize by the Bantu varies enormously, one report giving a range of 6–20 oz. per diam for urban dwellers⁵.

To throw light on the subject, breast milks from four groups of mothers have been investigated: (1) Urban Bantu mothers in poor circumstances whose consumption of maize meal (90–100 per cent extraction) exceeded 1 lb. per diam, and supplied 65–85 per cent of total calories; (2) Indian and Eurafian mothers consuming a small though variable amount of maize; (3) Bantu and Indian mothers accustomed to an almost Europeanized diet;

(4) European mothers in comfortable circumstances who served as controls. Milk from groups 1–3 mothers were obtained, mainly from 10.30 a.m. to noon, when subjects were attending clinics for routine examination of their infants or themselves. All collections were 'spot' samples. Nevertheless, self-demand feeding is the rule among non-White mothers, that is, differences in composition between 'fore' and 'hind' milks are thereby minimized. Niacin was determined microbiologically by the method described by Gyorgy⁶. Tryptophan determinations were carried out—on milks from groups 1 and 4 mothers only—by the microbiological method of Greene and Black⁷. Estimations of intakes of niacin and tryptophan were calculated, using local⁸ and American⁹ food tables respectively, from dietary information collected by our dietitian, Miss J. L. Seward. These data, together with results of the determinations of these nutrients in the breast milks, are given in the table.

INTAKES AND BREAST MILK CONCENTRATIONS OF NIACIN AND TRYPTOPHAN OF BANTU AND OTHER MOTHERS

Group of mothers	Niacin		Tryptophan	
	Intake (mgm./diam)	Breast milk (μ gm./100 ml.)	Intake (mgm./diam)	Breast milk (μ gm./100 ml.)
1. Bantu (high-maize diet)	15–18	70 $\pm$ 51 (28)* (15–140)	550–850	23 $\pm$ 6 (18)* (11–33)
2. Indian and Eurafian	not estimated	105 $\pm$ 45 (15)* (60–175)	not estimated	not estimated
3. Bantu and Indian (Europeanized diet)	not estimated	150 $\pm$ 52 (8)* (83–270)	not estimated	not estimated
4. European	9.5–15	175 $\pm$ 48 (8)* (110–226)	1,100–1,400	21 $\pm$ 4.5 (12)* (13–29)

* Number of milks examined.

Digestion of group 1 breast milks with *N* sodium hydroxide for 10 min. at room temperature caused no increase in niacin concentration; hence, the vitamin is present wholly in 'unbound' or available form¹⁰. The difference between the means of the niacin concentrations in groups 3 and 4 mothers is not significant; in this respect, therefore, the racial factor is unimportant.

The salient observation is that, despite a probably higher intake of total niacin, the mean niacin concentration in breast milk of the high-maize Bantu mothers is much lower than the mean value for the combined groups 3 and 4 mothers consuming the European diet. The difference is statistically highly significant ($P < 0.001$). Calculation reveals the loss of niacin in the breast milk to be small in comparison with total niacin intake—approximately 5 per cent for group 1 mothers at the third month of lactation.

Considering the results as a whole: first, wide variations of niacin concentration occur within groups, as with other constituents¹¹; secondly, mean niacin concentrations increase with decreasing maize consumption. Obviously, it would be erroneous to interpret differences in niacin concentration in terms of maize intake only. However, it would seem reasonable to regard the unusually low concentration of the vitamin in Bantu breast milk as reflecting a further abnormality of niacin metabolism under conditions of high maize intake. Whether the abnormality is due to a large proportion of ingested niacin being 'bound', or to suppression of intestinal

biosynthesis of the vitamin, or to other causes, requires further investigation.

The low intake of niacin by Bantu breast-fed babies is not apparently deleterious, for local pediatricians aver that there is parity of growth and general health between Bantu and European babies when exclusively breast-fed up to six months.

There is no statistical difference between the mean concentrations of tryptophan in the breast milks of the Bantu and European mothers (groups 1 and 4).

The determinations of niacin and tryptophan were carried out by Mr. G. Smith and Miss H. S. P. Snyman, of the South African Bureau of Standards, Pretoria. This communication is published with the permission of the South African Council for Scientific and Industrial Research.

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Formation of Enzymatically Active, Dialysable Fragments during Autodigestion of Pepsin

NORTHROP and co-workers have shown¹ that pepsin in solution digests itself with the formation of material soluble in trichloroacetic acid. The amount of non-protein substance formed depends upon factors such as time, temperature, and the pH and composition of the solvent. It has now been found in this laboratory that if autodigestion of pepsin proceeds at pH values removed from those optimal for proteolysis, pH 1.5-2.0, activity can be recovered in the non-protein fraction.

In a typical experiment, 0.6 gm. Worthington crystalline pepsin is dissolved in 60 ml. 0.1 M sodium acetate buffer of pH 5.6. The solution is then incubated at 37° C. and 10-ml. samples are withdrawn at intervals of 12, 18, 24, 30, 36 and 48 hr. and quickly chilled to 5° C. A portion of each sample is next dialysed at the low temperature for 24 hr., against 2.5 volumes of the acetate buffer. With the aid of the haemoglobin method², the activities of the protein, both before and after dialysis, and of the dialysate are determined. Enzymatically active fragments are found in the dialysate after incubation at 37° C. for 24-48 hr. This material represents 10-20 per cent of the total protein and has an activity, per unit of nitrogen, of 1-5 per cent relative to that of the intact enzyme. The dialysable material is inactivated on heating to 100° C. for five minutes or on prolonged incubation at 37° C. After passage of the hydrolysate through a column of 4 per cent cross-linked 'Dowex 50', at

Table 1. ACTIVITY OF PEPSIN AND ITS AUTODIGESTION PRODUCTS ON HEMOGLOBIN AND ACETYL-L-PHENYLALANYLDIIODOTYROSINE

Preparation	Time of incubation at 37° C. (hr.)	mgm. Nitrogen per ml. of solution	Relative specific proteolytic activity per unit nitrogen*	
			Hemo-globin	Synthetic substrate
Pepsin, control	0	1.35	100	100
Pepsin	9	1.33	95	not tested
Pepsin, dialysed		1.28	110	not tested
Dialysate		0.1†	0	0
Pepsin	48	1.34	97	95
Pepsin, dialysed		1.16	93	100
Dialysate		0.2†	8	64

* The relative specific activity of a freshly prepared dialysed enzyme solution is taken as 100.

† Nitrogen values of the dialysate refer to 1 ml. of the original protein solution.

least two active components are isolated from the eluate. Similar results have been obtained with five crystalline preparations of pepsin, although the amount of active dialysable material found on incubation varies somewhat with the length of storage of the crystalline enzyme. In all these experiments, tests for bacterial contamination were made in order to eliminate this as a source of activity.

Although, as indicated with a typical experiment listed in Table 1, the activity of the dialysable fraction against haemoglobin is low, that against the synthetic substrate acetyl-L-phenylalanyldiiodotyrosine³ is 64 per cent of the value for the intact protein. It thus seems reasonable to suppose that the active fragments may represent a portion of the original protein with an amino-acid configuration specific for the hydrolysis of a peptide bond adjacent to a tyrosine residue⁴. In contrast, the low activity against the protein substrate may be taken as an indication that proteolysis of haemoglobin involves a variety of types of bonds, for some of which the dialysable fragment has a reduced activity.

I wish to thank Dr. Lillian E. Baker for a generous sample of acetyl-L-phenylalanyldiiodotyrosine and Dr. Lewis G. Longworth for suggestions during preparation of the manuscript.

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Oct. 27.

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Effect of Temperature on Leaf-shape in *Ranunculus*

In trifoliate species of *Ranunculus* the first-formed and juvenile leaves are undivided, and as the plants mature the adult trifoliate or biternate condition is gradually taken up by new leaves. Quite frequently, however, some of the later leaves of mature plants show a partial reversion to a less divided, more juvenile form. This reversion may occur in leaves of similar age in many plants in a single area, which suggests a temporary or seasonal environmental cause.

An investigation has recently been carried out to determine the separate effects upon leaf-dissection

of differences in humidity, light-intensity and temperature. Using a pair of controlled-environment cabinets¹ it has been possible to grow plants for extended periods varying only one of the three major environmental factors at a time. Batches of twenty-seven adult plants of *Ranunculus hirtus* B. and S., a trifoliate species of forests in Australia and New Zealand, were grown for three months under each set of conditions. Illumination throughout was provided by Philips warm-white fluorescent tubes with a fourteen-hour day. The conditions that were applied are shown in the accompanying table.

Batch	Humidity (rel. per cent)	Light intensity (foot-candles)	Temp. (° C.) Day Night
1 A	95-98	{400}	{15 10}
B	45-50		
2 A	{90-94}	200	{15 10}
B		800	
3 A	{90-94}	{400 day}	{10 5}
B			

Although marked differences in size, habit and root-shoot ratio developed between the A and B batches of the first two experiments, no differences in leaf-dissection were produced. In the third experiment, however, marked differences in leaf-dissection were produced under different temperatures. Under the higher temperature there was a complete reversion to an undivided juvenile leaf-form in all leaves opening after six weeks from the start of the experiment. Under the cooler conditions the leaves kept their adult trifoliate form.

The reversion effect produced by the higher temperature persisted in new leaves for a further two months after the plants were replaced in the open at the end of the experiment. Subsequent leaves reverted to the original adult state.

This investigation has been carried out with the assistance of a Biological Research Grant and maintenance allowance from the Nuffield Foundation. A full account of this work will be published elsewhere.

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Dec. 23.

¹ N.S. J. Sci. and Tech., B, 35, 279 (1953).

Anatomy of Roots and Shoots of *Brassica campestris* L. in Relation to Vernalization

The present communication summarizes the results of a further study¹ of the comparative anatomy of plants raised from vernalized and normal seeds of mustard. The technique used for radicles, shoot apices and stems fifteen days old has been described elsewhere^{1,2}. Stems at the ages of 37, 45 and 56 days, using the method of Wilton and Roberts³, were fixed in formalin-aceto-alcohol, passed through the *n*-butanol series, embedded in paraffin, sectioned 15-18 μ thick and stained with erythrosin and crystal violet.

Radicle. The structure of the normal radicle and its vascular differentiation have already been described⁴. The following table presents a comparative study which shows that there is earlier initiation of differentiation of vascular elements in vernalized radicles.

Shoot apices. A search for differentiated protoxylem elements in the median traces of the various leaves on the shoot apices of plants 15 days old showed

Nature of seeds	Treatment	Condition of vascular elements at each pole	
		Protophloem	Protoxylem
Unsplit	Normal	No differentiation	No differentiation
"	Vernalized	One differentiated element	One differentiated element
Just split	Normal	"	One at various stages of differentiation
"	Vernalized	1-2 differentiated elements	2-3 differentiated elements

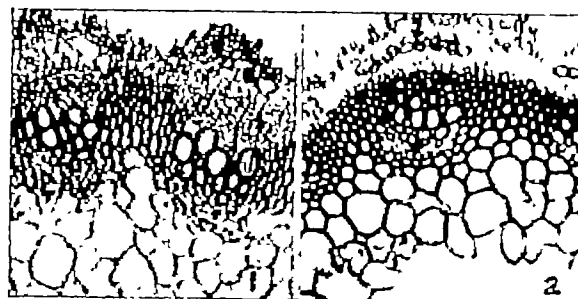
that in all the five plants obtained from treated seeds, the median trace of the fourth leaf from the apex has either a mature, an immature, or both types of xylem elements, while in the corresponding controls only two plants out of seven show this feature. Thus, in vernalized plants comparatively younger leaves have xylem elements differentiated first.

In the 15-day old sample, out of eight vernalized and seven control shoots examined, six apices of the former possess three layers of tunica and only two of the latter. Thus, the advanced stage of development marked by three-layered condition of the tunica⁵ is reached earlier in the vernalized material. A week later the apices of the treated plants have all the characteristics of a reproductive shoot⁶, whereas those of the untreated plants possess a three-layered tunica, the cells of which are approaching a columnar condition.

Stem. In the case of 15-day old material, scarcely any difference could be observed between the treated and normal ones, and there is vigorous cambial activity in both which starts in seedlings three to four days old. In the second sample (37 days old), the vernalized plants possess a pericycle zone the cells of which could be distinguished from the cortical ones whereas in the control plants they could not. The former also possess thicker-walled medullary ray cells and comparatively smaller vessel elements in the xylem, which is formed last.

In the sample collected at an age of forty-five days, besides the above-mentioned conditions, there is a greater thickening of the walls of the cells in the perimedullary zone of the vernalized plants. The cells in the bundle caps, medullary rays and perimedullary zone of the treated plants fifty-six days old are thicker-walled and they stain with crystal violet, as opposed to those of normal stems (Figs. 1 and 2). Again, the walls of the phloem cells in the vernalized plants are slightly thickened and more compressed, and there are few vessels in the latest formed xylem.

Thimann⁷ suggested that early flowering might result from the differences in the supply system and,



Figs. 1 and 2. Transverse section, second elongated internode below the terminal inflorescence of 56-day old control and vernalized plants of mustard, respectively. Arrow indicates bundle cap. $\times 100$

therefore, in the materials made available to the developing initials. Earlier differentiation of the vascular elements in vernalized mustard indicates that this is a possibility. A direct relationship between the flowering impulse and the activity of the cambium has been recorded by several workers¹. Struckmeyer² even observed a decrease in the activity of the cambium in plants within a short period of their subjection to photoperiods suitable for flowering. In the present case, however, no such abrupt change could be detected, and all the treated plants possessed a normally developed cambium, indicating thereby that the substance or substances formed during chilling are not direct flower-forming substances and thus differ from those synthesized in the leaves³ during photoperiodic treatment. Similar conclusions have also been arrived at by several workers with cereals⁴, although the substance or substances formed in mustard seeds during chilling differ from those in cereals in certain respects¹.

A detailed account of the comparative anatomy of mustard and several other plants will appear in the *Indian Journal of Agricultural Science*.

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Agra.
Sept. 26.

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Long-Term Adaptation to the Fermentation of Galactose in *Saccharomyces chevalieri*

THE dominant gene, controlling the adaptive fermentation of galactose, and the recessive gene, carried by the Carbondale stocks of *Saccharomyces* incapable of fermenting galactose, comprise a pair of extraordinarily stable and well-defined alleles. The non-fermenters of the Carbondale stock contain no detectable galactozymase and are incapable of fermenting galactose. Exceptional cultures called 'long-term' fermenters of galactose ferment galactose on duplicate tests after irregular periods of 4-30 days, while the corresponding stocks carrying the dominant allele cause fermentation within 48 hours. Mundkur and Lindgren¹ mated rapid-fermenter mutants isolated from 'long-term' fermenters with non-fermenters and found that the capacity for rapid fermentation segregated regularly at reduction, thus establishing the genic nature of the adaptation and the basis for the view that in the long-term fermenter a change occurs from non-fermenter to fermenter. The rapid fermentative character was retained by the original mutant and the segregant offspring after serial transfer on glucose.

Saccharomyces chevalieri is a 'long-term' fermenter different from the long-term fermenters of the Carbondale stock. Winge and Roberts² showed (1) that fermentation occurs regularly after a delay of 4-8 days, (2) that the adapted cultures ferment galactose rapidly, and (3) that most of them lose their ability to ferment galactose rapidly, that is, become 'de-adapted' after growth on glucose or maltose. They proposed that adaptation and de-adaptation involved

the entire population. Spiegelman, De Lorenzo and Campbell³ showed that the capacity for rapid fermentation is distributed discontinuously among the members of the rapidly fermenting culture. Mundkur⁴ found that matings between the rapid fermenters isolated from *S. chevalieri* and non-fermenter cultures of the Carbondale stocks produced hybrids in which the character for rapid fermentation segregated at reduction, proving that the change from non-fermenter to fermenter in *S. chevalieri* occurred as the result of mutation and selection of the mutant in the presence of galactose. He also indicated that the gene controlling rapid fermentation undergoes reverse mutation.

Nearly all *Saccharomyces* cultures produce variable numbers (1-10 per cent) of small smooth colonies which stand out in sharp contrast to the normal larger colonies on an agar plate. It was shown by Lindgren and Lindgren⁵ that most of the extensive morphological variation characteristic of *Saccharomyces* haploids arises from the small smooth colonies. Ephrussi⁶ found that the numbers of small smooth (petite) colonies can be increased by exposure to acriflavine and that both the spontaneous and the induced petites are deficient in cytochrome. *S. chevalieri* resembles other *Saccharomyces* in producing petite colonies which do not consume oxygen or utilize lactate⁷. Direct observation of budding has revealed that mitochondria are distributed to the bud at random and that some buds may receive only a single mitochondrion⁸, thus supplying the possible mechanism for the loss of cytochrome and the origin of petites. When petite colonies of *S. chevalieri* are plated on eosin-methylene blue galactose-agar containing peptone and yeast extract, the discontinuous nature of the transformation from non-fermenter to fermenter of galactose can be observed. By the seventh day nearly two-thirds of the colonies contain one or more red papillae. Subcultures isolated from the red papillae ferment galactose rapidly (within two days) and do not become de-adapted after serial transfer on glucose. These rapid fermenters of galactose retain the characteristic small size of petites and are respiratory-deficient, being unable to consume oxygen with either glucose or galactose as the substrate. The large colonies also produce normal papillae on *EMB* agar which overgrew the colonies by the fifth and sixth days. On the basis of Mundkur's findings⁴, it seems obvious that the discontinuous origin of the stable fermenters is by gene mutation.

Deliberate mixtures of the petite fermenter and the normal unadapted type were grown in glucose broth and on glucose-agar plates. In both cases the respiratory-sufficient normal strain overgrew the petite fermenter and the culture became 'de-adapted' to a long-term fermenter. Small numbers of stable rapid fermenters of the normal type in deliberate mixtures are inhibited by the presence of the normal unadapted strain when the two are planted in defined galactose agar. This phenomenon explains certain discrepancies encountered in fluctuation tests and validates the variance method in yeast genetics. It is inferred (1) that fermentation of galactose by *S. chevalieri* is due in part to mutation of a gene controlling galactose fermentation, and (2) that the fermenting culture is a mixture in which (3) de-adaptation is achieved by reversion to the non-fermenter type on transfer to glucose. The evidence presented above shows that a major mechanism in 'long-term' adaptation is mutation and selection, complicated by suppression; but, specific

DIFFERENTIAL BEHAVIOUR OF *Saccharomyces diastaticus* AND ITS
PETITE VARIANT IN ADAPTATION TO GALACTOSE

Classification of colonies	Respiratory activity of cells	Adaptation to galactose in fermentation tubes (defined medium)	Formenter papillae on colonies grown on MMS complete galactose agar	Characteristics of rapid fermenters of galactose
Normal (large)	Respiratory-sufficient; utilize lactate; consume oxygen	Fermentation completed in all tubes in 5-7 days	100 per cent of colonies contain one or more papillae by 3rd or 4th day; overgrown by 5th and 6th days	Normal (large colonies) respiratory-sufficient, rapid (two-day) fermenters of galactose; may become de-adapted
Petite (small)	Respiratory-deficient; cannot utilize lactate; do not consume oxygen	Fermentation irregular; completed in 9-18 days	Less than 1 per cent of the colonies contain papillae by 3rd or 4th day; 64 per cent of colonies contain one or more papillae on 7th day	Small colonies, respiratory-deficient, rapid (two-day) fermenters of galactose; do not become de-adapted

experiments were not devised which would exclude the possibility that mechanisms involving cytoplasmic particles or slow genes may co-exist. Most of the normal rapid fermenters of galactose yield de-adapted populations after growth on a galactose-free substrate. Some of the petite rapid fermenters derived from the de-adaptable respiratory-sufficient fermenters also become de-adapted. These data are consistent with the views that an extra chromosomal apparatus may be involved^{2,3}; the possibility that two mechanisms may operate simultaneously in adapting populations warrants serious consideration in formulating a concept of microbial adaptation.

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Oct. 30.

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Identification of the Genes for Maltose Fermentation in *Saccharomyces diastaticus*

Winge and Roberts¹ have established that *Saccharomyces cerevisiae* contains three polymeric genes for maltose fermentation, M_1 , M_2 , and M_3 , and they have obtained by mutation a fourth maltase gene (M_4).

It has been found² that *Saccharomyces diastaticus* contains two maltase genes, one governing normal fast fermentation (M_F) and one governing slow or delayed fermentation of maltose (M_S).

Prof. Ø. Winge has very kindly made available four hybrid yeasts each of which is homozygous for one of the genes M_1 , M_2 , M_3 , or M_4 . These yeasts were crossed, by Winge's spore-to-spore method, with cultures which were homozygous for M_F or M_S alone. Four-spored asci of the hybrids thus obtained were analysed for the segregation of maltose fermentation with the results shown in the accompanying table.

Crossing	Number of 4-spored ascus of the hybrid giving segregation of maltose fermentation 4+ : 0- 3+ : 1- 2+ : 2-			Probability of this distribution if the two genes are non-allelic allelic	
$M_F \times M_1$	6	0	0	0.0003	1
$M_F \times M_2$	2	2	1	0.06	0
$M_F \times M_3$	0	5	1	0.13	0
$M_F \times M_4$	1	4	1	0.16	0
$M_S \times M_1$	0	5	1	0.13	0
$M_S \times M_2$	0	6	0	0.09	0
$M_S \times M_3$	2	3	1	0.06	0
$M_S \times M_4$	1	3	2	0.08	0
Theoretical 2-gene segregation	1	4	1		

It is thus established that the M_F gene of *S. diastaticus* is M_1 . It is also established that the M_S gene of *S. diastaticus* does not correspond with any of the four genes M_1 , M_2 , M_3 , or M_4 , and it may be called M_5 .

The maltase gene in *Saccharomyces italicus* was also identified³ as M_1 , so that this gene is common to all the naturally occurring maltose-fermenting yeasts so far examined.

The Directors of Messrs. Arthur Guinness Son and Co., Ltd., have granted permission for the publication of this work.

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Nov. 4.

- ¹ Winge, Ø., and Roberts, O., *J.R. Lab. Carlsberg, Ser. Physiol.*, **24**, 263 (1948); **25**, 35 (1950).
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Environmental Influences and the Maxillary Index in *Anopheles gambiae*

APPARENTLY contradictory reports of the behaviour of *Anopheles gambiae* in different parts of Africa have led to suggestions that more than one biological race of this species exists. In French West Africa, Holstein¹ has attempted to correlate these differences with variation in the maxillary index—the number of teeth on both maxillae, divided by two. He has recognized a pseudidentate population with a maxillary index of 13.5 and a multidentate population with an index of 15. The former is said to be anthropophilic, mainly exophilic and to breed for preference in temporary pools in which the organic content of the water is low; the latter to be zoophilic, endophilic and to breed in permanent types of water of high organic content. Holstein has stated unequivocally that these two populations represent distinct biological races, and in this he has been supported by

Campbell², working in Gambia, who was able to confirm the difference in maxillary counts in females emerging from different breeding sites.

These conclusions are of considerable epidemiological and practical importance; but up to now it seems that critical attention has not been paid to the possibility that some of this morphological variation might be due to environmental influences. To explore this possibility the following experiment was carried out.

Individual egg batches were obtained from wild-caught *A. gambiae* from Muheza in Tanganyika. Each batch was divided into two parts, which were reared separately, with the object of finding a combination of breeding conditions that might have a maximum effect on the maxilla. One part was reared at a thermostatically controlled temperature of 32.2° C., the other at room temperature, which fluctuated around a mean of 21.1°. As it was found that overcrowding influenced both the maxillary counts and wing-length, an average of 100–150 eggs was put into the hot bowls, and, with the exception of the first experiment, 300–450 into the cool bowls. Thus 400–600 eggs were used in each experiment, the number of eggs taken from each batch depending on the number of batches available. Eggs were transferred to the appropriate bowls (12 in. × 10 in.) some 12–36 hr. after deposition; pupae were reared in separate containers but at the same temperature as their respective larvae. All larvae were fed on a suspension of a commercial preparation of yeast ('Perolin'). Little difficulty was encountered with feeding, although there was a considerable mortality among the later instar larvae in the crowded bowls.

The results of six experiments on these two genetically identical groups, shown in Table 1, gave striking evidence of the wide variation in maxillary index that could be induced by simple alteration of the larval environment. It appeared also that growth of the maxillae was not obviously related to linear growth as measured by wing-length (parents, 2.9 ± 0.06 mm.; hot bowls, 2.72 ± 0.06 mm.; cool bowls, 3.12 ± 0.06 mm.).

Table 1. MAXILLARY INDEX OF *A. gambiae* REARED UNDER DIFFERENT LABORATORY CONDITIONS. SIX EXPERIMENTS

Parents wild-caught	Progeny			
	hot, uncrowded bowls		cool, crowded bowls	
No. Max. index	No.	Max. index	No.	Max. index
3 14.6	30	15.7	26	15.2
14 14.2	22	16	59	14.1
16 14.3	50	15.4	39	13.8
20 14.5	25	16.1	21	14.6
5 15.5	52	16	35	14.4
5 14.6	37	15.9	32	14
63 14.5 ± 0.6	236	15.6 ± 0.3	212	14.3 ± 0.3

Egg-adult period

8–5 days

15–5 days

This work makes it clear that, unless adults are reared under standard conditions, no valid comparisons can be made of the maxillary indices of populations derived from different localities or breeding sites. On these grounds, the conclusion of Holstein and Campbell, that the differences between the two populations of *A. gambiae* that they studied were genetically determined, cannot be accepted as it stands; nor can the possibility be ruled out that much of this variation was phenotypical.

While differences of a geographical nature may, and probably do, exist, it must be concluded that there is no convincing evidence available at present

that points to the co-existence in the same region of biological races of this species.

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Nov. 11.

¹ Holstein, M. H., *Bull. med. Afr. occident. franc.*, No. spéc., 155 (1949).
"Biologie d'*Anopheles gambiae*", W.H.O. Mon. No. 9 (1952)

² Campbell, B. W. H., *Bull. Ent. Res.*, 43, 647 (1951).

Failure to Publish Scientific Results

I wish to direct attention to the large amount of scientific work carried out at the public expense but only reported in brief summary terms or published after long delay. This may be due in part to habits acquired in war-time, when the scientist was too busy to prepare papers for publication and the journals so restricted that they could not accept them. It is due also to the dangerous custom of writing a number of progress reports which are circulated within groups of Government committees in stencil: the authors frequently do not face the labour of preparing a paper of the type which a conscientious editor would accept.

It seems that an example is furnished by some of the work carried out under the Colonial Research Council*. Under that Council is a committee dealing with insecticides which met first in January 1947. Since the report for 1948–49, that Committee has referred each year to experiments being done with insecticidal sprays from the air in East Africa. It is evident from the page or so published that the investigation is well staffed (indeed in the last year the staff consisted of "4 entomologists, a physiologist, a chemist, a senior executive officer and 9 European assistants"); it also appears to be well planned: one notes that there is a careful estimation both of the insecticide that reaches the ground and of the insect populations which are the target. The group of workers carrying this out appear to have published no scientific papers until the end of 1953^{1,2}. These papers apparently deal with experiments carried out so long ago as March 1948.

It seems probable that the work done by this group in East Africa is more full and careful than that performed by any other country; but if one wishes to know about insect destruction by aerial spray, one must use the other people's work because it is available.

This British work on insecticides is lavishly financed and has received 7.5 per cent of the £12,000,000 allocated to the Colonial Research Council up to 1953, namely, £900,000. As most of the work carried out by the Insecticide Committee appears not to be very expensive, we conclude that the air spraying has cost about three-quarters of a million pounds. It is difficult to see why work should be done and paid for, if it is not made available or if it is to be published after it is out of date.

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* See p. 374 of this issue of *Nature*.

¹ Hocking and Yeo, *Bull. Ent. Res.*, 44, 590 (1953).

² Hocking, Parr, Yeo and Robbins, *Bull. Ent. Res.*, 44, 601 (1953).

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Monday, March 1

ROYAL SOCIETY OF EDINBURGH (at 24 George Street, Edinburgh), at 4.30 p.m.—Prof. James Kendall, F.R.S.: "Humphry Davy and his Connections with Scotland".

SOCIETY OF ENGINEERS (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. C. R. Young: "Progress in Petroleum Refining".

UNIVERSITY OF LONDON (in the Physics Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. B. Marshak (Rochester, U.S.A.): "Scattering of Mesons by Nucleons". March 3: "Nucleon-Nucleon Scattering at High Energies". March 5: "New Unstable Particles".

UNIVERSITY OF LONDON (in the Chemistry Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 5.30 p.m.—Prof. O. W. Fige, F.R.S. (Moulbourne): "The Flight Muscles of Insects". (Further Lectures on March 2 and 3.)

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.45 p.m.—Annual General Meeting.

Tuesday, March 2

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. A. J. Arkell: "Pebble and his Mycological Collection".

INSTITUTE OF CHEMICAL ENGINEERS (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. Hoog: "The Importance of Chemical Engineering Studies in Relation to Process Development".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 6 p.m.—Sir Lawrence Bragg, F.R.S.: "X-Ray Optics". (Further Lectures on March 9 and 16.)

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. F. Tyson: "Metal Sandwich Construction".

SOCIETY FOR VISITING SCIENTISTS LTD. (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Science of Clothing".

Wednesday, March 3

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. G. P. Whibberley: "The Challenge of Rural Land Losses".

SOCIETY FOR ANALYTICAL CHEMISTRY (in the Meeting Room of the Royal Society, Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Annual General Meeting; Dr. N. B. Hughes: "The Contribution of Public Analysts and Other Analytical Chemists to Public Welfare" (Bernard Dyer Memorial Lecture).

Thursday, March 4

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 3 p.m.—Dr. Irving P. Krick: "Weather Modification and its Value to Agriculture and Water Supply".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. A. A. Hall, F.R.S.: "The Work of the Royal Aircraft Establishment".

BRITISH POSTGRADUATE MEDICAL FEDERATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Prof. G. M. Bull: "Regulation of Body Water". (Last of fifteen lectures on "The Scientific Basis of Medicine".)

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 6 p.m.—Sir Harold Spencer Jones, F.R.S.: "Changes in the Rotation of the Earth". (Further lectures on March 11 and 18.)

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Dr. J. P. Dennison: "High Temperature Corrosion".

ROYAL AERONAUTICAL SOCIETY (at the Royal Fort Physics Laboratory, Bristol), at 7 p.m.—Major G. P. Bulman, O.B.E.: First Barnwell Memorial Lecture.

UNIVERSITY OF LONDON (at Wye College, Near Ashford, Kent), at 8.15 p.m.—Prof. P. B. Medawar: "Some Problems of Individuality in Cattle, Mice and Men".

Friday, March 5

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the COMBUSTION GROUP and the GLASGOW SECTION, in the Royal Technical College, George Street, Glasgow), at 2.30 p.m. and 7.15 p.m.—Scientific Papers.

SOCIETY OF COSMETIC CHEMISTS OF GREAT BRITAIN (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 7 p.m.—Mr. J. Pickthall: "Talking of Perfumes".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. H. Munro Fox, F.R.S.: "Oxygen and Life".

Saturday, March 6

LONDON COUNTY COUNCIL (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 2.30 p.m.—Mr. Norman Cook: "Roman London".

BRITISH INTERPLANETARY SOCIETY (in the York Hall, Caxton Hall, Westminster, London, S.W.1), at 6 p.m.—Mr. N. B. Nicoll: "The Design of a Life Compartment Necessary for Space Travel".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN PHYSICS, and an ASSISTANT LECTURER IN THEORETICAL PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (March 6).

PRINCIPAL OF BRITISH TECHNICAL COLLEGE—The Clerk to the Governors, 11 Essex Road, Dartford, Kent (March 6).

RESEARCH ASSISTANTS (8) (graduates, preferably in economics, agricultural economics, agriculture or geography) IN THE DEPARTMENT OF AGRICULTURAL ECONOMICS—The Registrar, Wye College, near Ashford, Kent (March 6).

SCIENTIFIC OFFICER (with first- or second-class honours degree in chemistry, geology or geography) IN THE DEPARTMENT OF PEDOLOGY, Soil Survey (Scotland) Section—The Secretary, The Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen (March 6).

HOSPITAL PHYSICIAN (basic grade) IN THE PHYSIC DEPARTMENT—The Secretary, Board of Governors, Hammesmith Hospital and Postgraduate Medical School, Du Cane Road, London, W.12 (March 9).

ASSISTANT LECTURERS (with special qualifications in physical chemistry, and for one post preferably with experience in surface chemistry) IN CHEMISTRY—The Registrar, The University, Manchester (March 12).

PARASITOLOGIST (with a degree in veterinary science, agricultural science or zoology) IN THE DEPARTMENT OF AGRICULTURE—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting Ref. No. 8/432 (March 13).

SENIOR PHYSICIST (with honours degree and at least five years experience in hospital physics or related research, and preferably with a practical knowledge of radio-elements)—The Group Secretary, Northern Group Hospital Management Committee, Royal Northern Hospital, Holloway, London, N.7 (March 13).

STAFF TUTOR IN SCIENCE (Physics or Chemistry) IN THE DEPARTMENT OF ADULT EDUCATION, to conduct University Tutorial or Seasonal Classes, to advise part-time tutors and to foster and organise the demand for scientific studies—The Registrar and Secretary, The University, Bristol 8 (March 13).

BIOLOGIST (with a university degree or equivalent qualification and some experience in freshwater biology)—The Borough Engineer and Surveyor, The Council House, Derby (March 15).

DEMONSTRATOR (graduate, with qualifications or special interest in either mineralogy and petrology or palaeontology and stratigraphy) IN GEOLOGY—The Professor of Geology, University College, Keele, Staffs (March 15).

J. H. ANDREW RESEARCH FELLOW (with some research experience) IN THE DEPARTMENT OF METALLURGY—The Registrar, The University, Sheffield (March 15).

LECTURER IN INORGANIC CHEMISTRY—The Registrar, Queen Mary College, Mile End Road, London, N.1 (March 15).

SENIOR LECTURER or LECTURER IN BIOLOGY, LECTURERS IN CHEMISTRY, PHYSICS, ZOOLOGY and MATHEMATICS, at the Nigerian College of Technology—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (March 15).

ASSISTANT CURATOR at the Coryndon Memorial Museum, Nairobi, Kenya—The Curator, Coryndon Museum, Box 568, Nairobi (March 20).

PRINCIPAL RESEARCH OFFICER or SENIOR RESEARCH OFFICER (with university honours degree in science, including advanced training in chemistry and botany, and preferably with research experience in the field of cell anatomy or cell physiology of plants) in the Commonwealth Scientific and Industrial Research Organisation, Commonwealth Research Station, Merbein, Victoria, to investigate the dipping, drying and processing of vine fruits, including studies of the chemical, physical and physiological processes involved—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 490/40 (March 20).

LECTURER IN ELECTRICAL ENGINEERING—The Registrar, The University, Manchester 13 (March 22).

DAIRY OFFICER (with a degree in dairying, or an equivalent university degree with dairying qualifications) in the Department of Agriculture, Southern Rhodesia Government—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (March 25).

SENIOR RESEARCH OFFICER or PRINCIPAL RESEARCH OFFICER (with university honours degree and special training and research experience in fuel technology or in applied chemistry, or equivalent qualifications) IN THE COAL RESEARCH SECTION, Commonwealth Scientific and Industrial Research Organisation, North Ryde, New South Wales, Australia, in connexion with a comprehensive survey of the chemical and physical properties of Australian coals, to be responsible for the Section's work dealing with either (a) the carbonisation of coals, and to undertake investigations, including pilot scale studies, of their coke and gas making properties, or (b) the cleaning and preparation of coals, and to undertake investigations into their drying, screening and washability characteristics—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting A.490/107 (March 29).

DIRECTOR (with high qualifications in one of the sciences bearing on animal health, and considerable research and administrative experience) OF MORRUM INSTITUTE—The Secretary, Animal Diseases Research Association, Morrum Institute, Gilmerton, Edinburgh (March 31).

I.O.L. RESEARCH FELLOWSHIPS IN BIOCHEMISTRY, CHEMISTRY, CHEMOTHERAPY, ENGINEERING, METALLURGY, PHARMACOLOGY, PHYSICS or allied subjects—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 31).

LECTURER IN STATISTICS IN THE DEPARTMENT OF MATHEMATICS, University of Cape Town, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, March 31).

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF BOTANY—The Secretary, University College London, Gower Street, London, W.C.1 (March 31).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

READER, SENIOR LECTURER or LECTURER (with special qualification in theoretical chemistry) in the DEPARTMENT of CHEMISTRY—The Registrar, The University, Manchester 13 (March 31).

TURNER and NEWALL RESEARCH FELLOWSHIPS in ENGINEERING, INORGANIC CHEMISTRY, PHYSICS or allied subjects—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 31).

RESEARCH FELLOW in the DEPARTMENT of MATHEMATICAL PHYSICS—The Registrar, The University, Birmingham 15 (April 20).

LECTURER in BIOCHEMISTRY—The Secretary, Queen's University, Belfast (April 30).

UNIVERSITY LECTURERS or UNIVERSITY DEMONSTRATORS in the FACULTY of ENGINEERING, University of Cambridge, to teach primarily in either the theory and use of materials, structural engineering or mechanical engineering—The Secretary, Appointments Committee, Engineering Laboratory, Cambridge (April 30).

JUNIOR RESEARCH FELLOWSHIPS in ORGANIC CHEMISTRY—The Secretary, Burbeck College, Malet Street, London W.C.1 (May 1).

RESEARCH FELLOWSHIP tenable in the DEPARTMENT of CHEMISTRY, University of Durham, for the study of nuclear reactions by radiochemical and micro gas-analytical methods—The Secretary, 38 North Bailey, Durham (May 1).

ROYAL DUTCH SHELL STUDENT (honours graduate in physics or geology, with mathematics and physics at intermediate level) in GEOPHYSICS—The Registrar, Imperial College of Science and Technology, London, S.W.7 (June 1).

ASSISTANT BACTERIOLOGIST (male) in the VACCINE LYMPH DEPARTMENT—The Bacteriologist-in-Charge, Lister Institute of Preventive Medicine, Herts.

ASSISTANT, Principal Scientific Officer grade (with first- or second-class honours degree in biology of a U.K. or Commonwealth University, or equivalent qualification), to the OFFICER in CHARGE, COLONIAL INSECTICIDES RESEARCH, for duties which will include the supervision of research work being undertaken under the aegis of the Colonial Insecticides, Fungicides and Herbicides Committee, and particularly the work of the Colonial Insecticides Research Unit in East Africa—The Under-Secretary of State, Research Department (S.610), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

BIOCHEMIST (with at least a B.Sc. honours degree, with three years postgraduate experience) in the East African Tsetse and Trypanosomiasis Research and Reclamation Organization, for duties which will include research on animal and insect physiology in connection with trypanosomiasis investigations in East Africa, routine biochemical tests, and to assist with biochemical problems in trypanosomiasis—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODH.77/88/OS.

CHEMIST, Scientific Officer grade, and a MYCOLOGIST, Scientific Officer grade—The Secretary, Ouseburn Experimental Station, Cheahunt, Herts.

ELECTRICAL or MECHANICAL ENGINEER (with first- or second-class honours degree or equivalent in electrical or mechanical engineering) at a Ministry of Supply Design Establishment, near Stevenage, Kent, for design and development of hydraulic and electrical equipment for A.A. mountings—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting O.113/64A.

ENTOMOLOGIST (with at least a good second-class honours degree, and with two years appropriate postgraduate experience) to investigate caterpillars and other insect pests of cacao and measures for their control; and an INSECTICIDE CHEMIST (with at least a good second-class honours degree, and with two years appropriate postgraduate experience) to test insecticides and methods for their application to cacao, including the design or improvement of machinery for this purpose, at the West African Cacao Research Institute, Gold Coast—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODH.87/11010-015.

GRADUATE PHYSICIST or FUEL TECHNOLOGIST (with ability to apply mathematics to heat transfer problems particularly concerned with the open hearth furnace) in the STEEL MAKING DIVISION, Sheffield—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting "Steel-making".

HOSPITAL PHYSICIST, Senior grade (with first- or second-class honours degree)—The Secretary, Liverpool Radium Institute, 1 Myrtle Street, Liverpool 7.

LIBRARIAN (with a pass degree in science subjects or a library qualification, coupled with experience in a technical library), and an ASSISTANT LIBRARIAN (with H.S.C. or equivalent in science subjects, and some technical library experience), in the Technical Library—Administrative Officer (Recruitment), Department of Atomic Energy, Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 17/WGH.

MASTER to TEACH MATHEMATICS up to University Scholarship standard, and a MASTER to TEACH SCIENCE—The Headmaster, The King's School, Peterborough.

PHYSICIST (with first- or second-class honours degree and some research experience) for (a) fundamental research on the diffusion of ions in the protein keratin, and related substances, using radio tracer methods, and (b) for investigation of the mechanics of fibre movement using electronic and radioactive techniques—The Wool Industries Research Association, Torrington, Headingley, Leeds, 6.

PHYSICISTS (with a good honours degree, and some experience or training in research, not necessarily in textile research) to work on textile problems—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, near Manchester.

SENIOR SCIENTIFIC OFFICERS (with first- or second-class honours degree in botany or agriculture or a pass degree in agriculture, and at least three years postgraduate or other approved service, and a knowledge of the economic aspects of crops, and wide agricultural experience abroad, and preferably with specialized knowledge of local conditions in the Colonies) at the ROYAL BOTANIC GARDENS, Kew—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting B.4280/34.

British Library of Political and Economic Science. (London School of Economics and Political Science: University of London.) Annual Report 1952/3. Pp. 20. (London: British Library of Political and Economic Science, 1953.) [16]

Air Ministry: Meteorological Office. Averages of Bright Sunsh. for Great Britain and Northern Ireland 1921-50. (M.O. 572.) Pp. 11+32. (London: H.M. Stationery Office, 1953.) 2s. net. [1612]

Institute of Personnel Management. Annual Report 1952-53. Pp. 19. (London: Institute of Personnel Management, 1953.) [2312]

The Registrar General's Statistical Review of England and Wales for the year 1949. Supplement on General Morbidity, Cancer and Mental Health. Pp. ix+184. (London: H.M. Stationery Office, 1953.) 7s. 6d. net. [2312]

Bulbed and Lipped Structural Aluminium Alloy Sections (Angles and Channels). (Addendum to Applications Brochure No. 6.) Pp. 12. (London: Aluminium Development Association, 1953.) [2312]

Privy Council. Medical Research Council: Special Report Series. No. 280: Vitamin C Requirements of Human Adults. A Report by the Vitamin C Subcommittee of the Accessory Food Factors Committee and A. M. Barnes, W. Bartley, I. M. Frankau, G. A. Higgins, J. Pemberton, G. L. Roberts and H. B. Vickers. Compiled by W. Bartley, H. A. Krebs and J. R. P. O'Brien. Pp. viii+179+24 plates. (London: H.M. Stationery Office, 1953.) 17s. 6d. net. [2312]

Report of the Ministry of Health for the year ended 31st December 1952. Pt. 2: On the State of the Public Health. Being the Annual Report of the Chief Medical Officer for the year 1952. Pp. v+250. (Cmd. 9009.) (London: H.M. Stationery Office, 1953.) 6s. 6d. net. [2312]

Other Countries

The National Research Council, Review 1953. (N.R.C. No. 3034.) Pp. 244+12 plates. (Ottawa: Queen's Printer, 1953.) 75 cents. [16]

U.S. Department of Commerce: National Bureau of Standards. Simultaneous Linear Equations and the Determination of Bismuth. (Proceedings of a symposium held August 23-25, 1951, in Los Angeles, California, under the sponsorship of the National Bureau of Standards, in co-operation with the Office of Naval Research.) Edited by L. J. Paige and Olga Tamarky. (National Bureau of Standards Applied Mathematics Series—Nr. 20.) Pp. iv+126. (Washington, D.C.: Government Printing Office, 1953.) 1.50 dollars. [1612]

6th Congreso Internacional de Microbiología. Symposium on Nutrition e Fattori di Crescita. Pp. 196. 1,400 lire; 16s. 6d. Inhibitori di Crescita e Chemioterapia. Pp. 142. 1,000 lire; 12s. 6d. Acidosi micotiche. Morfologia, Biologia e Sistemica. Pp. 231. 1,600 lire; 12s. 6d. Rapporti tra Virus e Cellule Ospite. Pp. 110+36 plates. 1,300 lire; 15s. Ottologia Batterica. Pp. 181+45 plates. 2,000 lire; 25s. Metabolismo Microbico. Pp. 143+1 plate. 1,000 lire; 12s. 6d. (Roma: Fondazione Emanuele Paterno; Oxford: Blackwell Scientific Publications, Ltd., 1953.) [2312]

Union of South Africa. Department of Agriculture. Bulletin No. 226 (Chemistry Series No. 186): Irrigation and Fertilization of Winter Cereals in the Karoo. By M. M. Walters and O. M. Havenga. Pp. 23. 3d. Science Bulletin No. 224 (Chemistry Series No. 201): The Fertilizer Requirements of Lucerne on the Vaal-Harts Irrigation Scheme. By Dr. J. Van Garderen. Pp. 11+56. 6d. Science Bulletin No. 239 (Chemistry Series No. 190): Chicory Production in South Africa. By Dr. H. B. Orchard and G. Van Rooyen. Pp. 76. 1s. (Pretoria: Government Printer, 1953.) [2312]

Catalogues

"Quickit" Interchangeable Laboratory Glassware Catalogue. Pp. 178. (Stone, Staffs: Quickit and Quartz, Ltd., 1954.) Leaflet No. 53. Pp. 2. (Oroydon: Oroydon Precision Instrument Co., 1954.)

Towers Analytical Balances. Pp. 14. (Widnes. J. W. Towers and Co., Ltd., 1953.)

Decro Indicator, for the detection and continuous measurement of traces of oxygen and hydrogen in gases. Pp. 2. (London: Baker Platinum, Ltd., 1953.)

Cambridge Instrument Company, Ltd. Sheet No. 318: Cambridge Ultraviolet Polarograph Unit. Pp. 2. Sheet No. 302B: Cambridge Polarograph (Direct Writing Pattern). Pp. 4. (London: Cambridge Instrument Company, Ltd., 1953.)

Equipment for Zoology, Histology, Botany. Pp. 42. (London: P. K. Dutt and Co., Ltd., 1953.)

"Service to Science" No. 26. Pp. 4. No. 27. Pp. 4. Scientific Instruments and Apparatus. (Oroydon: Townson and Mercer, Ltd., 1953.)

Let the Picture Tell the Story. (Picture Projection by Aldis.) Pp. 24. (London: Neville Brown and Co., Ltd., 1953.)

Sunvic Scientific and Industrial Catalogue. Data Sheet No. 1: Energy Regulators. Data Sheet No. 2: Vacuum Pumping and Gauging Equipment. Data Sheet No. 3: Vacuum Pumping Accessories. Data Sheet No. 4: High-Speed Continuously Self-Balancing Graphic Recorder, Types R.S.P. and R.S.P.M. (London: Sunvic Controls, Ltd., 1953.)

A. Gallenkamp and Co., Ltd. Publication No. 543: Laboratory Incubators. Pp. 4. Publication No. 551: Reagent Bottles—Bramelled or Sand-Blasted Lables. Pp. 6. (London: A. Gallenkamp and Co., Ltd., 1953.)

Royal Photographic Society of Great Britain. Library Catalogue. Second Supplement (1950-53) to Author Catalogue, 1939. Pp. iv+23. (London: Royal Photographic Society of Great Britain, 1953.)

Matthey Standards for Quantitative Spectrochemical Analysis. (Publication No. 1763.) Pp. iv+6. (London: Johnson, Matthey and Co., Ltd., 1953.)

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEERING BURSARIES IN CONCRETE TECHNOLOGY

Notice is hereby given that the election to bursaries in Concrete Technology, tenable as from October, 1954, will take place in June, 1954. Candidates must hold a degree in engineering at the time of taking up the award, and must also have a good knowledge of the theory of structures. Bursaries are of the value of £350 per annum, out of which the College tuition fee has to be paid; the amount may be increased to £450 for those with industrial experience. In addition, one or two Senior Bursaries of £600 per annum may be awarded to outstanding men with a minimum of three years' experience in industry. The course will be postgraduate and Bursars who successfully complete the course will be eligible for award of the Diploma of the Imperial College (D.I.C.).

Applications must be received on or before June 1, 1954, by the Deputy Registrar, City & Guilds College, Exhibition Road, London, S.W.7, who will, on written request, send full information and application forms.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

ENGLISH ELECTRIC COMPANY'S BURSARIES IN HYDRO-POWER ENGINEERING

Notice is hereby given that a number of English Electric Company Bursars in Hydro-Power Engineering will be elected in June, 1954. The Bursaries are of the value of £250 for one year, tenable for graduate study in the Civil Engineering Department of the Imperial College. Bursars pay appropriate College tuition fee. The Bursaries are recommended for supplementation by the Ministry of Education. Bursars who successfully complete the course will be eligible for the award of the Diploma of the Imperial College (D.I.C.). Candidates should have an honours degree in engineering or an equivalent qualification.

Applications should be received before June 1, 1954, by the Deputy Registrar, City & Guilds College, Exhibition Road, London, S.W.7, from whom further details may be obtained.

SALTERS' INSTITUTE OF INDUSTRIAL CHEMISTRY

FELLOWSHIPS

Applications are invited for a Salters' Fellowship, value £600 per annum (plus university fees, and with F.S.S.U. benefit), for a graduate with an honours degree in chemistry, biochemistry, physics or engineering, in order that the appointed Fellow may obtain special training in industrial chemistry and contribute to the improvement of processes and products of industry by research in the field of the chemical sciences (including chemical engineering). The Fellowship will be tenable for one year from September 1, 1954, and renewable for one further year.

Applications should be received by the Clerk of the Salters' Company, 36 Portland Place, London, W.1, by March 31, 1954. Forms of application may be had on request.

INSTITUTION OF ELECTRICAL ENGINEERS

SCHOLARSHIPS

The Council of The Institution of Electrical Engineers will consider for award this year three Research Scholarships, one Graduate Scholarship, and six Student Scholarships, as follows: Research Scholarships, Oliver Lodge, value £420 for one year, may be extended for a second year; I.M.E.A., value £420 for one year, may be extended for a second year; Swan Memorial, value £250 for one year. Graduate Scholarship, for full-time postgraduate study, Silvanus Thompson, value £400 for one year. Student Scholarships, for study at undergraduate level at a University or a Technical College: Silvanus Thompson, value £200 per annum for three years; Manville, value £150 per annum for three years; W. B. Eason, value £120 per annum for two years; Salomons, value £60 for one year; Paul, value £50 per annum for two years; Thornewood, value £25 for one year. The closing date for the receipt of applications is May 1, 1954, for Student Scholarships and June 1, 1954, for Graduate and Research Scholarships.

Full particulars of the conditions of award attached to each scholarship and nomination forms may be obtained on application to the Secretary, The Institution of Electrical Engineers, Savoy Place, London, W.C.2

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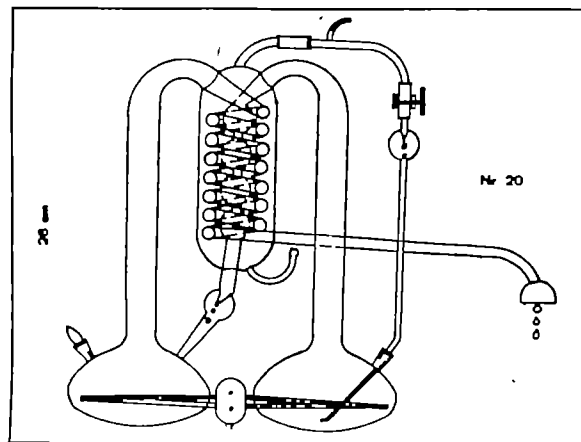
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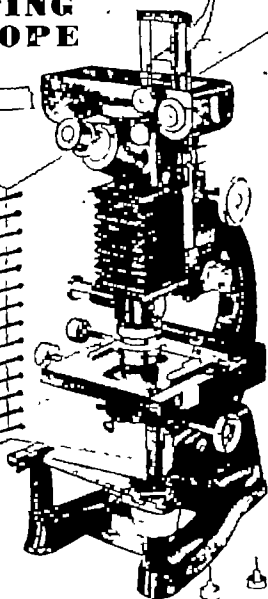
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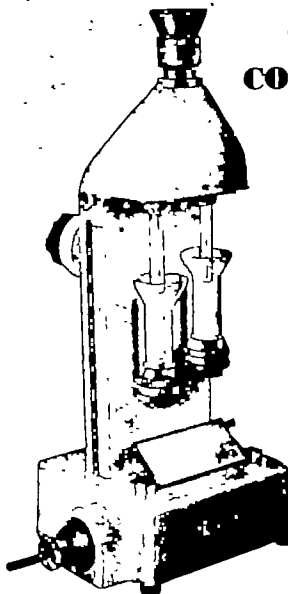
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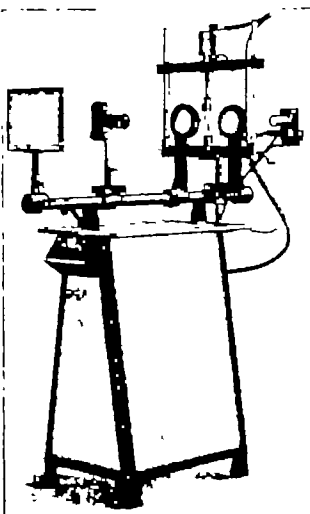
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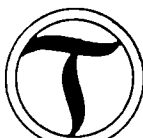
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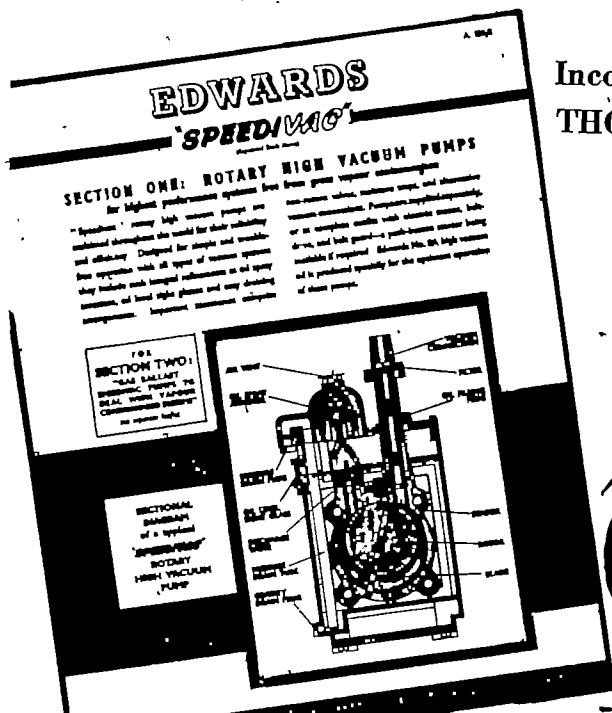


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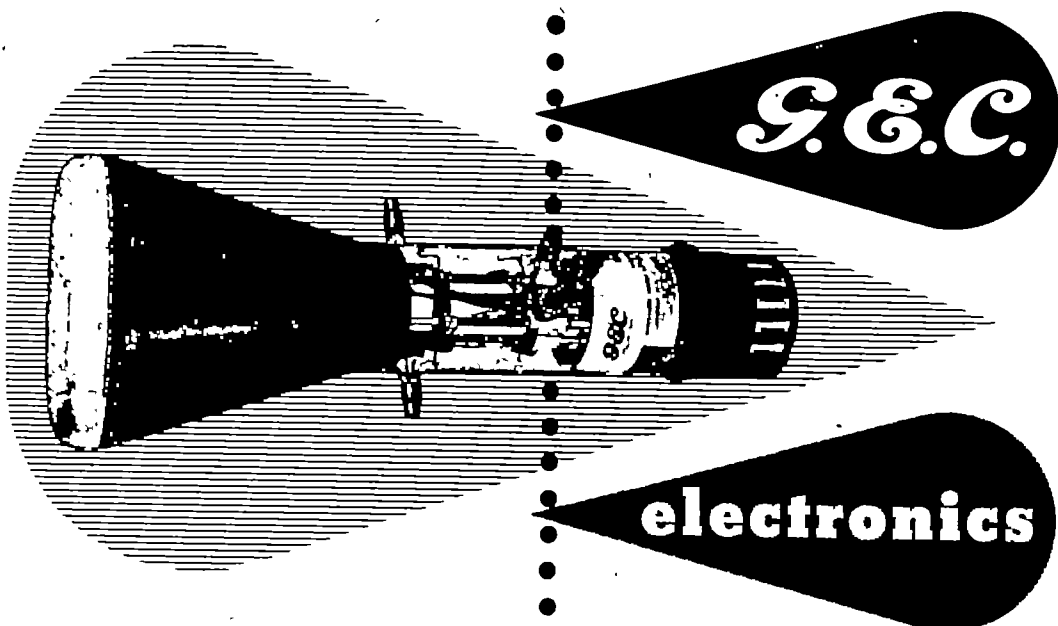


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Base: B12D

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Vp.d.a.3 (max.) 10kV
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Sy (av.) 0.27mm/V
Screen: Killed blue—
photographic
Base: B12D

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NATURE

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THE NATIONAL PARKS COMMISSION

THE fourth annual report of the National Parks Commission*, which covers the year ended September 30, 1953, contains a record of some useful work carried out under disheartening difficulties. Progress is reported in regard to the 'long-distance routes': proposals for a Pembrokeshire Coast Path and for a Cornwall South Coast Path were submitted during the year and the former has been approved by the Ministry. It is clear that the Commission's advice on development questions is being freely sought; the Commission was successful in securing a modification, acceptable to all parties, of the route originally proposed for the 275-kV. grid line from Newcastle to Carlisle, which was to run through part of the area suggested by the Hobhouse Committee as the Roman Wall National Park. It has been less successful in the defence of the Peak District National Park against encroachment of mineral working, especially limestone quarrying. Except for his decisions on the Gantrees Hill and Hartington new proposals, and the reopening of the Cotterhole working, the Minister of Housing and Local Government's decisions were far removed from the recommendations of the Commission and those of the Peak Park Board. The Commission is also manifestly uneasy about the Services land requirements; here again it would appear that the Services have been allowed to judge their own cause and to claim, as essential to defence, areas of great natural beauty in which such developments are clearly undesirable.

Despite, however, the existence of a considerable measure of goodwill, manifested, for example, in the numerous examples of development proposals handled by the Commission, as detailed in Appendix B to this report, the Commission's fourth report is a record of frustration and disappointment which may well prompt the question whether it was worth while establishing the Commission at all.

So far as the public is concerned, it is clear from the Commission's fourth report that there are still widespread misapprehensions as to the nature of a national park, and the effect of designation of an area for that purpose on public access or on farming and other activities in the area. Some at least of the opposition to the Commission's proposals for designation is due to such misconceptions, and it might in practice be sounder policy to concentrate on the task of education rather than, as the Commission itself seems inclined to do, to accelerate the process of designation. It is true that the Commission is naturally and rightly anxious to complete the process before spoliation or encroachment by public bodies has gone so far that irretrievable damage has been done to the areas indicated in the Hobhouse Committee's report. Nevertheless, designation alone is ineffective unless an appropriate administrative authority is created. So long as the Minister of Housing and Local Government and also Parliament refuse to face this issue,

* National Parks Commission. Fourth Report for the year ended September 30, 1953. H.C.18. (H.M.S.O., 1953) 2s. 6d.

local authority parks such as we are now being given cannot be protected adequately against the inroads of government departments and public corporations.

The creation of the North York Moors National Park brought the total area of the six national parks in England and Wales to some 3,400 square miles. Since the report was signed, the chairman of the Commission has signed, on December 7, 1953, an order designating some 680 square miles in the North and West Ridings of Yorkshire, while on January 27, in spite of the opposition of the Devon and Somerset County Councils, to which the report refers, an eighth area was designated in the Exmoor National Park. The Commissioners, however, in this report record some disappointment at the progress now being made in the designation programme; and in the main this disappointment appears to be due to the greater reluctance now encountered on the part of local authorities to concur in the designation of national parks within the area of their responsibility.

One example is Exmoor, already noted. Another instance is to be found in the proposals for a Cornwall National Park. Consultations with the eighteen local authorities concerned began in June 1952, and, as the report notes, the proposal of the Commission that the county's coastal territory should be designated a national park received a warm welcome. In spite of this, local doubts and reservations eventually led to a recommendation of the Cornwall County Council that the project should be deferred *sine die*. The Commission replied that it could not acquiesce in the suggestion that the intentions of the National Parks Act, as the Commission interprets them, should be suspended in this way in Cornwall, and although the County Council declines to comment on the boundaries proposed for the park, the Commission proposes to renew discussions at the appropriate time.

The Commission's disappointment arises in general from the fact that previously such reluctance to consider readjustments in local administration involved by the Act as a corollary to the designation of any given area had usually been overcome more or less successfully. It now appears that not only do misapprehensions as to the purposes and effects of the national parks persist and prejudice the reception of proposals, but also that the economic atmosphere is more unpropitious, for local rates have risen and increased the unwillingness to countenance change. Generally speaking, the Commission believes that the administrative consequences account for the reluctance of local authorities to implement the National Parks Act in their areas. It is not easy to demonstrate to those who are suspicious or sceptical even the short-term and palpable advantages accruing to local rate-payers from the designation of a national park in their area. Although, the report continues, the parks now in operation are taking in their stride, as it were, the anomaly of local authorities carrying the burden of responsibility for a national park, it remains an anomaly which becomes more of a stumbling block to new entrants to the scheme in times of financial stringency.

The National Parks Commission makes no criticism of Government policy; but it is perfectly frank and realistic. Its fourth report makes it crystal clear that the present unsatisfactory position is due to the failure of the Minister of Housing and Local Government to deal with the critical issues of finance, administration and local government reform. If the latter issue were handled with imagination and sympathy as well as wisdom, neither the financial nor administrative obstacles to the implementation of the National Parks Act would be so serious. In the absence of such reform, the intentions of the Act cannot be implemented.

There is no suggestion in this report that the views of the local authorities are to be disregarded. The Commission recognizes as clearly as the Minister himself that the success of the concept of the national parks scheme in Britain depends upon the willing co-operation of the local authorities, and it is anxious to proceed with the utmost degree of agreement attainable between the local authorities concerned and itself. In fact, the brightest feature of this report, as of the preceding report of the Commission, is the evidence it contains of a large measure of co-operation and goodwill.

A conspicuous example is to be found in the Peak Planning Board, which has won the warm support of some who originally opposed its formation. Generally speaking, the Commission believes that the planning boards or committees which have come into existence during the past three years are exercising their powers with growing resolution and with effect. Liaison between them and the Commission is growing, and the Commission takes the reasonable view that these boards and committees must be allowed time to grow. Spectacular or immediate results should not be demanded of them or of the Commission, but nevertheless the inherent limitations in the structure of the boards and in the powers of the Commission should be kept in mind: it is only subject to those limitations, and not according to the full intentions of the National Parks Act, that claims of amenity and beauty and of recreational facilities are being safeguarded.

The details of administrative arrangements in the six areas thus designated as national parks given, without further comment, in an appendix to this fourth report, show the magnitude of the deviation from the arrangements laid down by Parliament in the Act. The success of the Lake District Planning Board and the Dartmoor National Park Committee in dealing with specific matters such as caravanning and camping does not alter the fact that these and other park planning boards and committees have neither the constitution nor the independence which would enable them to take a national point of view, or the authority to resist encroachment, which Parliament intended they should enjoy.

There is thus good reason for welcoming the national campaign for the full operation and ultimate amendment of the National Parks and Access to the Countryside Act, which was launched at a week-end conference at Longshaw House last autumn, convened by the Ramblers' Youth Hostels,

and Co-operative Holidays Associations and the Holiday Fellowship. Informed public opinion and its influence on Parliament are the surest means of securing that the intentions of the original Act are implemented or any satisfactory amendments made to that Act. As Mr. A. Blankinsop pointed out at the conference, not much help can be expected from Parliament until the objectives of national parks are widely understood and more general enthusiasm is manifested for them.

The first need, accordingly, is, as has already been indicated and as was recognized at this conference, for a positive educational campaign on the part of the National Parks Commission and of the rambling and amenity organizations concerned. If the Commission's efforts are still hampered by lack of funds, the voluntary organizations could render valuable help in this task. Quite apart from the fact that, as the conference agreed, these organizations sometimes need to improve their own outlook, co-operation in the task could help to bring home to a large section of the community that a price has to be paid for amenity, and that ultimately the existence and effectiveness of national parks in Britain depend on the effort and resources the community is prepared to devote to that purpose.

Such an educational campaign must obviously include local authorities; their understanding and co-operation are essential if the objects of the national parks are to be achieved, though in the main it is through Government action, both financial and in regard to local government reform, that the reluctance of the local authorities to co-operate will be removed. On the second point, indeed, as is becoming apparent through the foot-paths survey and through the liaison between the Nature Conservancy and local nature reserves, the administration of the national parks offers an opportunity which, used with imagination, could bring fresh vitality to the local units. On the question of finance, Lord Chorley maintained at the conference that the national parks should get at least £1 million a year and that the Hobhouse Committee had been led to expect at least that amount.

Meanwhile, we can expect no more than that the National Parks Commission will be able to prevent irreparable damage until such an educational campaign as was projected at Longshaw has the appropriate effect on public opinion. Since the present report was published, the waterworks committee of one of our largest conurbations, without the knowledge of the city council and disregarding the findings of the Committee on Gathering Grounds and the intentions of Parliament, has sought to obstruct access to the Pennines and to get the decision of the National Parks Commission on the Pennine Way overridden by direct approach to the Minister. If, however, it proves impossible to rouse public opinion to insist that Parliament should no longer allow the purposes written into the existing Act to be flouted, repeal of the National Parks and Access to the Countryside Act would seem to be the wiser course. Respect for the law would then no longer be undermined by official indifference or local obstinacy, and a salutary check might be given to the disposition in a modern democracy to expect that

benefits can be obtained without either payment or effort on the part of beneficiaries. National parks, as the Commission observes in this fourth report, are not museum pieces. The danger, however, is not of stagnation on the part of the Commission but rather of inaction on the part of Government. Only an upsurging of public opinion, fully aware of what is at stake and prepared to pay the price involved in terms of finance or other resources, of legislation and of unceasing vigilance, is likely to bring Parliament or Government to the sense of urgency and to the action required to ensure that the prospect opened up by the successive reports of the Hobhouse and Huxley Committees does not fade away and the national parks and nature reserves prove no more than a mirage.

THE ACCRETIONARY ORIGIN OF COMETS

The Comets and their Origin

By R. A. Lyttleton. Pp. x+173+13 plates. (Cambridge: At the University Press, 1953.) 25s. net.

THE primary object of this book is the exposition of Dr. R. A. Lyttleton's own very interesting theory of the origin of comets, and he has set out "to lay this theory before as wide a circle of astronomers as possible". To render the book complete in itself, he has wisely decided to include an account of the main observational features of comets, and the first two chapters accordingly summarize our present knowledge of their dynamical and physical properties. There follows Chapter 3, which gives the core of the author's theory. He applies the theory of accretion to the passage of the sun through an interstellar dust cloud, and he finds that the result will be the formation of aggregates of interstellar dust describing nearly parabolic orbits around the sun. The orbits of these aggregates would afterwards be modified by planetary perturbations. There is no reason to doubt that the sun may have passed through interstellar dust clouds during its history, and Dr. Lyttleton has now shown that the result of such a passage will be the formation of aggregates of cosmic dust which, when quantitative estimates of size and density are taken into account, seem to be remarkably like comets.

The plausibility of this identification is strengthened in Chapter 4. Here Dr. Lyttleton is led to the conclusion that near the perihelion passage of one of his dust aggregates collisions will operate so as to pulverize some of the particles, and in this way dust may be produced which is fine enough to respond to the radiation pressure of sunlight. This very fine pulverized dust would be blown away from the sun and would so form a 'tail'. The reader is here left with the impression that Dr. Lyttleton's dust aggregates formed by accretion look still more like comets.

The last chapter discusses the relation of the author's theory to earlier ideas, and no special comment on this chapter seems to me to be necessary. With regard to the theory as a whole, it must be emphasized that Dr. Lyttleton has gone some way towards working it out on a quantitative basis with the view of the comparison of his aggregates of dust with comets as we know them. So far, the working out seems to support the hypothesis. Naturally, to

quote Dr. Lyttleton's own words, "there is room for further investigation at many if not all points". A good deal of the working-out process is given in some detail in the book, but the mathematics involved is elementary, and the author has fulfilled his aim of catering "for as wide a circle of astronomers as possible". The book is readable, its standard of presentation is high, and there are some excellent plates and a valuable bibliography.

Dr. Lyttleton has made out, to say the least, a good *prima facie* case, and he has every right to expect that his theory be regarded as meriting detailed and searching analysis and criticism. His book is to be commended to all interested in the subject.

W. M. H. GRIMMES

THE PHILOSOPHY OF DESCARTES

New Studies in the Philosophy of Descartes
Descartes as Pioneer. By Prof. Norman Kemp Smith. Pp. xii+360. (London: Macmillan and Co., Ltd., 1952.) 25s. net.

Descartes' Philosophical Writings
Selected and Translated by Prof. Norman Kemp Smith. Pp. vii+316. (London: Macmillan and Co., Ltd., 1952.) 25s. net.

IT is surprising how little of interest or importance has been written in English on the philosophy of Descartes, in view of the extent to which his main writings are still read by students of philosophy in Britain; by comparison, English work on Spinoza, who is now virtually unread, is of far greater significance. Until the publication of Dr. L. J. Beck's "The Method of Descartes" last year there was no large-scale study in English of Descartes's contributions to logic and scientific method, and even now we lack an adequate discussion of his metaphysics. Prof. Norman Kemp Smith's "New Studies" go some way to fill the gap: making full use of the results of recent French scholarship, they examine Descartes's thought stage by stage and show how his preoccupation with first-hand scientific issues led him to enunciate a clear-cut doctrine of method and a bold metaphysical dualism which he later, with doubtful consistency, qualified in the hope of bringing them into more obvious accord with the facts.

As a contribution to the history of thought, the book is interesting if not conspicuously original; read as an independent discussion of some of Descartes's leading philosophical theses, it is less satisfactory. It is well to stress, as the author does, the pioneer spirit which underlay Descartes's enterprise to provide a purely mechanistic physiology, especially when one remembers the state of knowledge at the time. As the "Discourse on Method" makes clear, it was to medicine and mechanics, not to mathematics or even philosophy, that Descartes hoped to make permanent contributions. But it should surely be stressed on the other side that, if Descartes here showed some of the insight of genius, he also betrayed all too clearly the defects of his qualities; for, despite many disappointments, he never gave up the idea that a final science of Nature could be arrived at, and, as Gilson and others have demonstrated, he never gained a sufficient understanding of the importance of facts. Hence his account of scientific method is at once strikingly right and alarmingly wrong.

But it is when we turn from logic to metaphysics that the defects of Prof. Kemp Smith's treatment

are most obvious. We learn from his book why Descartes was inclined to metaphysical dualism and how his position was afterwards modified by his recognition that (in his own words) "I am lodged in my body not as a pilot in a ship; but so intimately conjoined, and as it were intermingled, with it, that with it I form a unitary whole". There is an interesting discussion of what the author calls "natural beliefs" in this connexion, in which it is argued that Descartes anticipated Hume, but nothing whatsoever is said of the attacks made in recent years on Cartesian metaphysics as resting on a series of "category-mistakes". It may be that these attacks are crude, but they are not too crude to be taken seriously. Similarly, Descartes's "hyperbolic" doubt is expounded in his own terms, and the limitations with which he used it are clearly brought out; but no attempt is made to meet the criticism of this sort of scepticism expressed by writers like Wiedem. Nor are the logical subtleties of the *cogito* argument explored as they deserve to be.

Prof. Kemp Smith has supplemented his "New Studies", which replace an older volume of his published fifty years ago, by a new translation of a selection of Descartes's philosophical writings. He has done this, he writes, because he finds existing versions, whatever their merits, to be written with insufficient understanding of Descartes's views and often with insufficient attention to the nuances of his vocabulary. These are good reasons for making fresh translations, and when the translator is as practised and successful as Prof. Kemp Smith the work is doubly welcome. It is perhaps a pity, however, that he did not offer to revise and expand the Cambridge translation by Haldane and Ross instead of producing a volume which is necessarily incomplete; and he might well have confined his notes entirely to philological matters and abstained from comment on matters of substance, seeing that his comment has to be highly selective and in fact varies considerably in bulk from treatise to treatise.

W. H. WALSH

THE WORKS OF GEORGE BERKELEY

The Works of George Berkeley, Bishop of Cloyne
Edited by A. A. Luce and Prof. T. E. Jessop.
(Bibliotheca Britannica Philosophica.) Vol. 5: *Siris*, *Three Letters to Thomas Prior, A Letter to the Rev. D. Hales, Farther Thoughts on Tar-water, Varia*. Edited by Prof. T. E. Jessop. Pp. xi+236. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1953.) 30s. net.

THE fifth volume of the new edition of Berkeley consists of his last major work, with minor writings related in subject-matter. "Siris" advocates practical therapeutic measures in terms of scientific theories now obsolete, depending on philosophical concepts now almost forgotten. In its own day "Siris" was Berkeley's most popular work. His tar-water, which long survived in the "Pharmacopoeia" as *aqua picis*, served a useful purpose—a mild antiseptic for internal or external application that could do no harm and might do much good in many common ailments. It could be prepared by any housewife from common ingredients at trifling expense. It is true that Berkeley thought of it as a

panaceas, but panaceas were still respectable. In his arguments he used the best available medical knowledge. These arguments were much better than those for the Brunonian system of therapy, which had some professional support later during the eighteenth century, and as good as those for the homoeopathic system which enjoyed considerable popularity during the nineteenth century. But his arguments were based on alchemical concepts and are now almost unintelligible. They are interesting, though, because they bring out very clearly the underlying metaphysics, from which alchemy derived its genuine, as apart from its fraudulent, appeal.

This metaphysics is the ancient faith in the Great Chain of Being, a faith practically universal in folklore and prevailing in most Greek philosophy. Even the atomist Lucretius, who should have repudiated it, is strongly tinged with it. It is well summarized in a sentence from one of the early "Hermetic" works which Berkeley quotes. "All parts of the world vegetate by a fine subtle ether, which acts as an engine or instrument, subject to the will of the supreme God". It requires only the further statement, that there is one universal material substrate which this ether informs or transforms, striving to bring into existence more perfect from less perfect forms. Any modern who is shocked by this kind of view should read Newton on natural transformations in Query 80, appended to his "Opticks". He should note that where he differs from Newton and Berkeley is in the metaphysics he uses to order the evidence before him far more than in the evidence itself, which could all be taken in alchemical terms.

Prof. T. E. Jessop provides a useful introduction, in which he disposes of the claim that the thought of "Sirius" is inconsistent with Berkeley's earlier works. He has also hunted up the often very obscure references given in the text, and has printed in an appendix the passages in Boerhaave's "Elementa Chemiae" of which Berkeley makes extensive use. Altogether, it is a volume of which editors and publishers may well feel proud. A. D. RICHARDS

BAND SPECTRA OF DIATOMIC MOLECULES

Tables de Constantes et Données numériques

5: Constantes sélectionnées. Atlas des longueurs d'onde caractéristiques des bandes d'émission et d'absorption des molécules diatomiques. Établi par R. F. Barrow, A. D. Camt, A. R. Downie, R. Herman, E. Hultdt, A. McKellar, E. Miescher, B. Rosen et K. Wieland. Pp. 390. (Paris: Hermann et Cie., 1952.) 5600 francs.

FOR atomic spectra, tables of collected measurements of lines arranged in order of wave-length are of considerable value for identification; indeed, books such as Kayser and Ritzsch's "Hauptlinien" and Harrison's "M.I.T. Wavelength Tables" are indispensable. There is a natural tendency to attempt a similar project for the banded molecular spectra. However, the problem is different and much more difficult. Whereas individual lines can often be measured with great precision, band spectra are more often observed with rather small dispersion, and the accuracy of measurement is much less. Even with big dispersion, the exact location of the band heads is complicated by the rotational fine structure of the bands, the choice of head position

often depending to some extent on the instrument used, the source in which the band is excited and even on the observer. Often, too, there are complications due to overlapping rotational structure from another band. Whereas for atomic spectra each main electronic transition is responsible for a single multiplet of relatively few lines, with molecules each transition leads to a whole band system, and it is usually preferable to try identification of systems rather than of individual bands.

Volume 4 of "Tables de Constantes sélectionnées" was produced in 1951 by the same authors as the present volume, and contained a very useful collection of data of the spectra and molecular constants of individual diatomic molecules. The present volume is essentially a supplement to this, and most of the previously listed bands, with a few more from recent literature, are grouped into one table, containing nearly 18,000 heads of 299 molecules. They cover the wave-length range 15,050–672 Å. For each band, the direction of degradation, emitting molecule, electronic transition (where known), vibrational transition, and up to four of the characteristic or strongest bands of the system are listed. No indications are given of the appearance of the band (that is, how many heads), the type of sources in which it may be expected or intensity relative to others of the system. The term "Atlas" should not be translated literally; there are no photographs or diagrams. The volume also includes wave-length lists, involving 2,500 heads, of bands of C_2 , OH, OH^+ , CN, CO, CO^+ , N_2 , N_2^+ , NH, NH^+ , NO, O_2 , O_2^+ , OH and OH^+ separately; these are mere lists of wave-lengths without indication of direction of degradation, system or intensity, and it is difficult to imagine any use for them. The volume also contains a list of about four thousand lines of H_2 , with their transitions.

It is natural to compare this volume with Pedree and Gaydon's "Identification of Molecular Spectra", an earlier attack on the same problem. This also included a much shorter list of principal band heads in order of wave-length, but relied mainly on photographs and individual tables. The present volume has the advantage of including the photographic infra-red and far ultra-violet regions, but the disadvantage that it is strictly limited to diatomic molecules, whereas Pedree and Gaydon included the main triatomic and polyatomic molecules and also gave indications of band appearance and sources in the main list. The much greater size of the table in the volume under review is not necessarily a big advantage. In the main visible and near ultra-violet region there are three or four bands to an angstrom, so that with the normal accuracy of measurement several chance coincidences will inevitably occur for each band head. In many cases the selection of material seems poor. Thus, as examples, about fifty heads of BaBr are listed around 5400–5150 Å., whereas the six main sequence heads should be sufficient; for the extensive $B \rightarrow X$ system of Te_2 , about a hundred heads are included. This does not really make identification more certain; it merely confuses the issue by increasing the number of chance coincidences.

The volume can, of course, only be made use of in conjunction with the previous Vol. 4, and in view of the limited usefulness of tables of this kind, unless supplemented by photographs, the high price would seem to put it in the luxury rather than the utility category. A. G. GAYDON

Elsevier's Encyclopædia of Organic Chemistry
 Edited by F. Radt. Series 3: Carboisocyclic Condensed Compounds. Vol. 14, Supplement, Triterpenes. Co-edited by Dora Stern. Pp. xxxii+939S-1346S+Ind. 50. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1952.) £11 to subscribers.

IN the original Vol. 14 of this "Encyclopædia", published in 1940, 85 pages were devoted to a survey of the chemistry of the triterpenes. The fact that 407 pages of this supplementary volume are needed to summarize the literature belonging mainly to the period 1937-46 reflects the enormous amount of attention given to this considerable group of natural products during the decade. There seems every justification for the claim that the literature concerning the structures of the compounds is covered up to 1952. To a very large extent these structures have now been fully established, and several of the major groups of triterpenes have been inter-related. A number of gaps could now be filled by work which has been published since the appearance of the present volume, and much could now be written of the stereochemical relationships, which receive scarcely any mention.

The general characteristics of Elsevier's "Encyclopædia" are now so familiar that it is unnecessary to reiterate them. The usual excellence of production is maintained, and the features which are especially attractive in this volume include the following: the elaborate but beautifully clear charts illustrating conversions and reactions of the various groups of triterpenoids; a systematic list of compounds arranged according to the carbon skeletons which their molecules contain; and an alphabetical list of natural triterpenoids, grouped together in the index. It is quite an achievement to have found a misprint: this occurs in the first line, where the year 1945 is erroneously given as 1941.

It is a foregone conclusion that this volume is now in constant use by all workers in the field. It is safe to predict that it will also arouse the interest of a much wider circle of chemists.

Advanced Experiments In Practical Physics

By J. E. Calthrop. Second edition, revised throughout by Dr. J. A. Pryde. Pp. xvi+144. (London: William Heinemann, Ltd., 1952.) 10s. 6d.

IT is a pleasure to welcome the revised version of Mr. J. E. Calthrop's excellent book, even though it was not possible for this revision to be done by the original author. In producing the second edition, Dr. J. A. Pryde has accomplished a not too easy task in a very satisfying way, and, as is inevitable in such cases, certain alterations have been made, particularly in the section on electricity and magnetism, while new experiments dealing with valves, dielectric constant, conductivity and thick lenses have also been included.

To those who are not acquainted with Mr. Calthrop's book—and surely there can be few honours physics students in Britain who are not—it is only necessary to suggest that they should remedy this deficiency without delay. The book is designed specially for honours students and contains a series of fifty-five experiments grouped in three sections; and although the experiments vary in their standard of difficulty, each one is interesting and should be of inestimable benefit to the student from the point of

view both of acquiring knowledge and of improving technique in practical work. The book concludes with a collection of additional problems and a list of useful books on the practical teaching of physics.

The standard of work set and presented by Mr. Calthrop was very high; the new edition certainly preserves that standard, and the book can be thoroughly recommended.

General Topology

By Prof. Wacław Sierpinski. Translated by O. Cecilia Krieger. Second edition. (Mathematical Expositions, No. 7.) Pp. xii+290. (Toronto: University of Toronto Press; London: Oxford University Press, 1952.) 48s. net.

STARTING with the definition of a Frechet (F) space, and making no assumptions concerning the 'neighbourhoods' involved in the definition, Prof. W. Sierpinski proceeds, in Chapter 1, from derived set to closed and open sets. The open sets so defined are seen to satisfy the axioms for a topological space except that the intersection of two open sets may not be open. With these 'minimum' assumptions, several theorems on continuity, separation, connectedness and compactness are established; these extend considerably the results in Chapter 1 of the first edition of the book.

In Chapter 2, axioms for a topological space are assumed. After spaces the topologies of which have a countable base have been considered, Hausdorff spaces which satisfy the first countability axiom are studied; this makes a change from the first edition.

The remainder of the book covers approximately the same ground as the first edition, but with some deletions, some additions, and several improvements, notably in the shape of problems and examples. There are also changes in terminology to conform with standard usage introduced since the first edition was published.

The appendix by O. C. Krieger on cardinal and ordinal numbers is almost unchanged from the first edition. R. G. COOK

Calculus

By Prof. O. R. Wylie, Jr. Pp. x+565. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 48s.

THE distinctive feature of this first course in calculus is the great care taken by the author to make the subject interesting and intelligible to students of limited ability and small preliminary knowledge, who are told in advance the objective of each discussion, why a particular method is used, and what pitfalls have to be avoided. It is commendable that the author has scrupulously avoided the unsound arguments that occur in many elementary books. When the sound proof is too difficult for the beginner to understand, the theorem is stated without proof, for which a reference is given to a more advanced book.

The first chapter gives an excellent general outline of the leading ideas of both differentiation and integration. The later chapters go beyond most first courses, and include some account of physical applications, partial differentiation, multiple integration, Fourier series and differential equations. There are a great many examples (all with answers), a summary at the end of each chapter, an index, tables, formulae from other branches of mathematics, and a glossary of technical terms. The only defect of the book is its high price. H. T. H. PRAGGIO

THE ELECTRON MICROSCOPE IN BIOLOGY*

By Dr. RALPH W. G. WYCKOFF, For.Mem.R.S.

Science Attaché, American Embassy, London

TWO recent developments in the human mind have contributed to produce modern natural science. One is a more acute sensory perception and objective awareness of the outer world. The other is an equally striking enlargement of the intellectual ability and willingness of many men to deal with these clearer perceptions of Nature, to relate them logically one to another and to devise from these relationships a consistent pattern of outer happenings. This enhanced sensory awareness of external reality expressed itself in the painting and sculpture of the Renaissance; and more or less simultaneously there arose, sometimes in the same individual, that closer and more purposeful observation of natural phenomena which was a root of modern science. In art this clearer perception enriched immeasurably the world of human values which art serves; in science it began to furnish that basis of external fact which must underlie any sound understanding of the meaning of human existence.

Only a rudimentary natural science could, however, have arisen from such unaided observation, no matter how acute, or how carefully it was analysed. The intimate knowledge we now possess of the texture of the universe is the direct result of the invention and use of instruments to extend and render ever more quantitative the limited information our senses can supply.

Vision is, of course, the sense that has taught us most about Nature; and it is therefore natural that instruments which extend its range will have been most actively sought and most highly valued. It was the telescope that gave a first practical demonstration of the essential role of instruments; the microscopes that began to be made soon after started the equally important observation of fine structure which has now become the chief preoccupation of modern science. Every branch of science seeks first an accurate description of the gross appearance and behaviour of its segment of Nature; and this has customarily been followed by the attempt to analyse the matter that is present into its components and to ascertain significant relations between these components and the gross properties with which the original description was so largely concerned. In chemistry, this analysis has been achieved through the interpretation and correlation of elaborate series of chemical reactions. For certain other sciences, the microscope has been a much more direct analytical tool. Thus, the analytical stage for biology may be said to have begun when compound microscopes made accessible for study the individual cells that are the unit structures of living matter.

Since then, there has been a steady improvement in techniques of microscopy which, though providing very little extension in vision, have yielded a steady flow of new knowledge about the cellular level of organization. In our day, the electron microscope is

of such exceptional importance because it does give such an extension, and one that allows us not merely to see smaller detail but also to reach in biology the deeper and more fundamental level of organization where molecules are the units. For the past twenty-five years we have known that the proteins and many other substances extracted from living matter have very large molecular particles. A number of these particles have already been seen under the electron microscope, and the fact of this visibility takes us beyond chemistry's conventional concern with statistical molecular aggregates to observations on separate molecules and their interactions. It is the principal object of this discourse to illustrate some of the more immediate applications we have made of this ability to see macromolecules.

Before doing this, however, I must give some idea of the great extension in vision already achieved with this new microscope. The limiting resolving power of any optical system defines its ability to portray small objects: it depends on the wave-length of the illumination we use. Optical theory has demonstrated that no microscope can possibly reveal the true shape of an object smaller than about half this wave-length. Accordingly, visible light cannot delineate objects smaller than c. 0.2 micron (about a hundred-thousandth of an inch); with ultra-violet light we can do little better. Electron microscopes, though only about fifteen years old as scientific instruments, have already portrayed objects more than a hundred times smaller than this in linear dimensions and hence more than a million times smaller in volume and weight. Such tiny particles are only five to ten atoms across. The newly visible world having such relatively small molecules as its lower limit is about as extensive, and as full of unknown things, as that aspect of Nature which the optical microscope first brought to light. It will take a long time to discern all that is here, and still longer fully to understand what we are seeing. In the meantime, we have all the excitement of seeing what no man expected to see, and of using much of the new knowledge thus gained to approach with clearer understanding many of biology's essential problems.

An indication of the relationship of the electron microscope to the familiar optical microscope may help in interpreting the images it produces. Seventy-five years ago, in 1879, Sir William Crookes demonstrated in the Royal Institution various forms of his new cathode-ray tube. The electron microscope is such a tube in greatly elaborated form. Like the Crookes tube, it has a source of electrons and a fluorescent screen to show their pattern; a magnetic field is commonly used to change their direction. In the electron microscope there are several of these fields, and they are so arranged that the electrons follow paths through the tube that imitate the path of light through the glass lenses of an optical microscope.

From a consideration of what an electron microscope is, it will be realized that there is no compelling technical reason why we should not have had some

* Substance of a Friday Evening Discourse at the Royal Institution delivered on December 11. The Discourse was illustrated by a series of electron micrographs from among which the accompanying figures were taken; an electron microscope was also demonstrated and its images shown to the audience on several television receivers. This demonstration was arranged through the courtesy of Philips Electrical, Ltd., and R. M. Industries, Ltd.

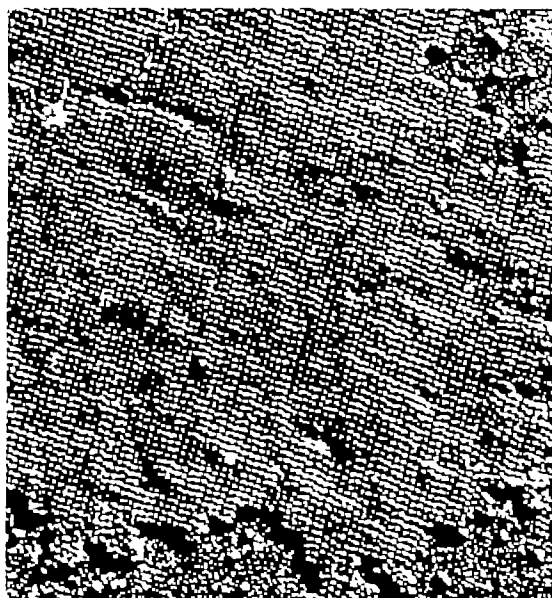


Fig. 1. Early stage in the crystallization of a necrosis virus protein. The orderly arrangement of the particles is apparent. $\times 40,000$

form of this instrument many years ago. Probably it was not built because its advantages become obvious only when our realization of the wave qualities of the electron started people thinking about it as an illuminant. Here is, in fact, a rather striking example of how our scientific imaginations may be bound by the ideas current at any time.

In science, as in most other fields of human endeavour, we rarely get everything we would like, and accordingly, it should not be a surprise that there are important limitations to what can be looked at under an electron microscope. For the most part these arise from the relative impenetrability of matter by electrons; therefore, the object must be extremely thin and, after thorough drying, it must be examined under the vacuum of the tube. This is not an overwhelming disadvantage; but it makes necessary new methods of specimen preparation that will preserve the structures we are interested in, down to their finest molecular details.

To delineate very small objects we must look at their very highly magnified images; this involves magnifications far greater than those useful in optical microscopy. The detail seen in the best optical microscopes becomes increasingly 'fuzzy', indistinct and meaningless when viewed at magnifications above about $1,500\times$; but we can now have electron micrographs in which detail is sharp at $150,000\times$. Occasional electron micrographs are worth studying at twice this magnification. These magnifications are so vastly in excess of any in our previous experience that most of us find it difficult to have a vivid realization of how very small are the objects we are seeing.

Many novel problems arise when we use the electron microscope to see molecular particles. In it, objects are visible by reason of the electrons they deflect, or scatter; and a molecular particle is able to deflect very few compared with the substrate that must be used to support it. This lack of a necessary contrast in the resulting image can be met by evaporating a few atoms' thickness of heavy metal obliquely over a preparation. Then contrast is enhanced by the little atomic shadows cast by molecular and other detail, and these have the added advantage of giving the image a three-dimensional quality that reveals the shapes of what we see.

There is one very important difference between the practice of optical and of electron microscopy, made necessary by the destructive effects of powerful electron beams. In general, the optical microscopist does most of his work visually and only occasionally takes a picture. The electron microscopist, on the contrary, uses visual images mainly to find and to focus on fields of interest. By then taking pictures on fine-grained photographic film and enlarging them later, he is able to obtain very high useful magnifications without employing the destructive electron intensities that would be needed to give bright images at these highest enlargements.

It is impossible to do more here than show what a few typical macromolecular particles are like, and indicate some of the problems dealing with them that are now claiming our attention. In essence these problems are threefold. They involve recognizing and measuring the particles, determining how they are arranged in the structures they form, and trying to find out how they are produced in Nature.

The proteins that occur in solution in a living organism offer many examples of approximately spherical macromolecules. When sufficiently purified, these substances often crystallize well, and we can study with the electron microscope various stages in



Fig. 2. Section through a swollen tendon. Two or three unswelled fragments show their characteristic striations. $\times 21,000$

the growth of the single crystals they form. The photographs that have been obtained from a number of proteins and plant virus proteins show the beautiful molecular order that characterizes all steps in crystal formation (Fig. 1).

Another highly important type of molecular particle is a long filament. The thicker among these are relatively stiff and straight, like the tobacco mosaic filaments in old solutions or the elementary particles of cellulose. Those that are thinner are wavy threads. Solutions of the muscle proteins, of collagen from connective tissue and of the nucleic acids contain such threads; some that have been photographed are less than ten atoms in diameter. Paracrystalline, rather than crystalline, solids composed of these filamentous macromolecules are among the important framework structures of plants and animals. Their investigation is one of the most rewarding of the current applications of electron microscopy. Filaments display a striking tendency to assume parallel arrays. Thus, the secondary walls of plants consist of stacked sheets of parallel aligned filaments of cellulose. Striated muscle has a parallel alignment of molecular threads as a sort of backbone for its other components. Sections cut at right angles to a muscle fibre demonstrate many fine details of an ordered packing of these threads that in some places is almost crystalline in its perfection. Evidently the kind of knowledge that will result from such observations permits an entirely new approach to the problem of muscular contraction.

An equally good but very different type of molecular order prevails in tendon and other forms of connective tissue. Collagen, for example as Achilles tendon from the heel, has been examined as shredded fragments and in sections cut in various directions through an intact tendon. At low magnifications not much above those used in optical microscopy, one sees the tiny fibrils that are associated together in bundles and sheets to form the macroscopic tendons.

Higher magnifications reveal the fine structure of each component fibril. The examination of transverse sections suggests that a fibril is enveloped by a tube of collagen; preliminary swelling shreds the collagen and shows how its macromolecular particles are knitted together to produce such a tube (Fig. 2). Collagen dissolves in very dilute acids and alkalis and can be re-precipitated from its solutions. The electron microscope demonstrates that under certain conditions these re-formed fibrils have the molecular fine structure of the original collagen, but that under other conditions of precipitation fibrils of different fine structures are produced. Some of these are found in Nature, others are not. Such investigations of the various forms of collagen are important, not only for their bearing on the nature of paracrystalline order, but also because they permit us to study the changes in connective tissue that accompany and perhaps may sometimes be responsible for arthritis, rheumatism and similar degenerative diseases of man.

When we seek to deal with the third broad field of study opened up by electron microscopy—how these macromolecular particles arise—we immediately realize the need first for an adequate picture of the fine structure of the living cells that produce them. Most of what we know about the cells that constitute the higher plants and animals has been gained from optical microscopic studies on thin sections of their tissues. To extend our observations to electron microscopic magnifications it has been necessary to learn how to cut sections that are about fifty times thinner than those required for this optical work. Such wafers of tissue only a few millionths of an inch thick can now be cut as a matter of routine. With them we are beginning to survey again some of bacteriology and many problems of histology and embryology from the point of view of the new detail that is to be seen. Artefacts formed during specimen preparation obviously are more troublesome the finer the structures being studied,

and new methods must be developed before we can utilize to the full the potentialities of the electron microscope. Nevertheless, the progress already made has revealed far more than we can yet interpret within sectioned tissues.

Innumerable questions can be answered from the examination of healthy cells. If they are from plants we can, for example, follow the growth of their walls and we can examine the fine structure of their chloroplasts, of their starch grains and of the many other objects to be seen in their cytoplasm. If they are of animal origin, we can inquire into the elaborate mitochondrial and other structures that are particularly striking in cells of special function such as those in the liver or kidney, in the eye or the nervous system. With both plant and animal cells we can approach from this finer level of organization the mechanism of cell division (Fig. 3).

These studies of components of the normal cell and of how they develop supply the background

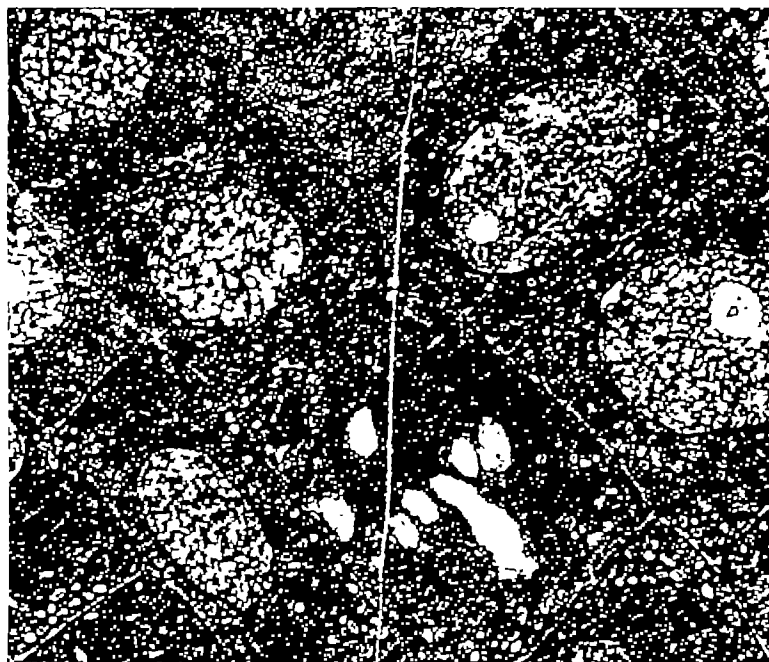


Fig. 3. Section through an onion root tip showing parts of several resting and one dividing cell with its (sectioned) chromosomes. $\times 7,500$

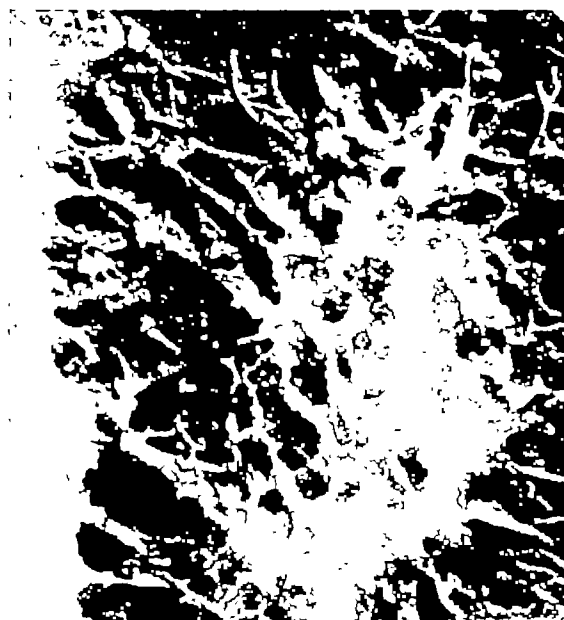


Fig. 4. A mass of influenza virus particles developed from a cell, the border of which appears along the left edge of the photograph. $\times 8,200$

requisite for investigating the abnormalities of cell life that are responsible for many diseases of living matter. Virus diseases are among the first of these to which we naturally turn, both because the viruses that cause them are too small to have been visible before and because, whatever their nature, these pathogenic agents stand on the borderline between the animate and inanimate and thus offer a unique opportunity of learning more about the essence of the living state.

My laboratory in the United States at the National Institutes of Health has been particularly concerned, over the past few years with this study of virus growth, and we have learned much about how several viruses develop within the cells that are their hosts. There appears to be no uniform pattern for this development, and one cannot briefly describe the various types of virus growth we have seen. Nevertheless, I would like in conclusion to indicate what we have found about one familiar virus—that of influenza. From an examination of purified suspensions, we know that its infectious particles are either tiny spheres or filaments of the same diameter. In sections through diseased tissues we find these virus particles not within the infected cells themselves, as many of us would have expected, but clustered around their peripheries and developing from them as filaments that break off and segment into spheres (Fig. 4). Such observations with the electron microscope demonstrate that the elementary infectious units of this virus have not proliferated after the fashion of minute micro-organisms but instead are bits of cytoplasm of the diseased cells.

The particles of several other viruses, including bacteriophages, are derived from the protoplasm of the host cells; but there are other viruses that do not have such an origin. Some appear to arise from specialized components of the diseased cell, whereas others may be foreign invaders that multiply like micro-organisms, by growth and division. Much more observation is needed before the full story of

virus growth is known; but it is important that we at last have a method capable of giving this knowledge.

At this early stage in our explorations with the electron microscope it is not possible to foresee what new insights into the vital process it will next give us. Perhaps they will come as we address ourselves more and more towards the small viruses, especially those that attack nervous tissue; or perhaps we shall find more immediately rewarding the closer study of the numerous structures that are steadily being found as we examine a widening range of healthy cells. Whichever it is, we may be sure that our visual penetration of the macromolecular level of organization will prove steadily more fruitful as experience gives us an increasing ability to interpret the new things we observe.

CENTRAL LABORATORIES FOR SCIENTIFIC AND INDUSTRIAL RESEARCH, HYDERABAD

Opening Ceremony

THE new buildings of the Central Laboratories for Scientific and Industrial Research, Hyderabad, were opened by Shri Jawaharlal Nehru on January 2, in the presence of distinguished guests, foreign scientists, delegates to the Indian Science Congress and eminent industrialists.

Rashttrapati Rajendra Prasad sent a special message for the occasion, conveying his best wishes for the successful fruition of the endeavour made by the State for the advance of science. He further stated that: "It goes without saying that money spent on research is rightly regarded by all progressive nations as a sound investment made for the common weal. Attempts like these, therefore, deserve all encouragement that the State could give in the interest of human progress and happiness. I congratulate Hyderabad State for establishing these laboratories and fervently hope that those who would have the privilege of working in these laboratories would be inspired by the lofty ideal of rendering service to humanity".

Dr. Husain Zaheer, director of the Central Laboratories for Scientific and Industrial Research, in his address emphasized the importance of regional laboratories working in co-operation with the national laboratories for the overall development of scientific and industrial research in India. The immediate and early exploitation of new inventions, he said, requires a degree of technical skill and finance which is usually not available even in countries like Britain, with the result that a great majority of such discoveries made during the past twenty years were first exploited in the United States. He therefore emphasized that the main activities of the laboratories, at least for some time to come, will be directed not so much towards making new discoveries or inventions as towards developing and adapting already known methods and techniques. Consequently, the work in the Laboratories has been concentrated on developmental work of modern methods and on adapting them to the industrial needs and requirements of this region.

The Prime Minister, Shri Jawaharlal Nehru, in his speech referred to the scientific progress the world has made during the past few years; he said that science has changed the whole world, and this must be accepted by India. While the people in India had begun to realize the importance of science, he believes that there are still many who do not realize the necessity or importance of scientific research. He added that, despite able administration, no country can progress without science; scientists and engineers are far more important than administrators. The administrators have, no doubt, their place, but it is secondary to that of scientists and engineers. It is therefore necessary that scientific research should make progress in India.

Dealing with the division of work among the various laboratories, the Prime Minister said that, for a big country like India, both general and special laboratories are necessary. It is desirable to have the laboratories spread out in different regions so that the scientific outlook should become familiar throughout the country. But, he said, there should be no waste of energy in regard to the work done by these laboratories. One individual or institution cannot do everything thoroughly and efficiently; the standard of work must be maintained at a high level. Duplication of work may sometimes be necessary, but there must be no waste. Mr. Nehru felt that a general laboratory for the south of India was appropriately sited in Hyderabad, and hoped that the work there would contribute to the progress and prosperity of this region as well as of the whole country.

After the buildings of the Laboratories were declared open, the Prime Minister and distinguished guests inspected them and also the cotton-seed processing pilot plant and the pilot plant for the low-temperature carbonization of coal.

General Aims of the Laboratories

The Laboratories were established in 1944 by the Hyderabad Government on the initiative of the Council of Scientific and Industrial Research. But due to unsettled political conditions in the State, the full plan could not be carried out immediately. Dr. S. Hussain Zaheer took charge of the Laboratories as director in November 1948, and submitted a detailed scheme for their organization and development to the governing body. He laid emphasis on developmental and pilot-plant research utilizing the raw materials of the State. The scheme was approved by the governing body in March 1949. The then Military Government took an active interest in the implementation of the plan. Extensive lands were acquired near the Osmania University campus. The foundation stone of the new buildings of the Laboratories was laid by Major-General J. N. Chaudhuri, Military Governor of the State, on November 6, 1949.

The main building is in the shape of a T, with administrative block, the auditorium and the museum forming the two wings and the laboratories forming the central block, which consists of a basement and four floors. The ancillary buildings consist of four large pilot-plant buildings, workshop, electricity sub-station and the gas house.

The first stage, which has been completed, consists of a basement, ground floor (excluding auditorium and museum), first floor, two pilot-plant buildings, workshop, electricity sub-station, gas house and store house for inflammable chemicals, with a total floor area of 86,000 sq. ft. The total expenditure on

buildings has so far been Rs. 21 lakhs. Approximately Rs. 30 lakhs has been spent up to now on pilot plants, equipment and apparatus, etc.

The main purpose of the Laboratories is to carry out developmental research of an industrial nature covering the fundamental as well as applied aspects of each problem. Research problems taken up for investigation are initially put forward by research committees, government departments or industries, or are brought up during discussion between the director and research workers. The problem is discussed in detail in the Operational Research Unit and a decision taken regarding its importance and feasibility. Afterwards, information relating to the availability of raw materials, demand for finished products, their market prices, etc., is collected and a 'literature note' is prepared incorporating all the data available. This note is discussed anew by the Operational Research Unit and a detailed programme of work with a time target is drawn up. On successful completion of the laboratory investigation, the Pilot Plant Committee studies the chemical engineering aspects of the problem concerned in its translation to the pilot-plant stage, and prepares a non-technical note with approximate costings, for circulation among interested industries. Pilot-plant experiments are then undertaken either in the Laboratories or by industries, and an industrial process is evolved on the basis of these trials. The pilot-plant schemes are also sent to the various specialized bodies of the Government of India; like the Indian Central Oilseeds Committee, the Council of Scientific and Industrial Research, the National Research Development Corporation and others.

In the selection of the research programme, every effort is made at all stages to co-ordinate the work with that of the National Laboratories, and care is taken to avoid unnecessary duplication of effort.

Work of the Sections

The *Fuel Section* has concentrated mainly on a detailed study of all aspects of the utilization of the rich and extensive deposits of coal in Hyderabad State. A detailed survey of the coal deposits has been under way during the past three years. Recently, the Council of Scientific and Industrial Research, Delhi, has entrusted these Laboratories with similar work on the available deposits of lignite coal in Madras State. Washability tests on coal of high ash content are regularly carried out in a modern type of heavy-medium separation plant on a semi-large scale. The Tatas are interested in the washability tests of coal and have requested the Laboratories to carry out similar tests on coal from Digwadih (Bihar). A 25-ton/day plant employing the Lurgi process of low-temperature carbonization of coal, the first of its kind in India, has been erected and is in operation for testing non-caking coal of this State as well as similar coal and lignite from other parts of the country. Problems connected with the low-temperature carbonization of coal, such as study of tar, ammoniacal liquor, and recovery of tar acids, benzole, etc., are under investigation. It is proposed to set up, shortly, experimental units for tar hydrogenation and pressure gasification.

The *Heavy Chemicals Section* has, in view of the sulphur shortage in the country, carried out considerable work on sulphates as an alternative source of sulphur. Work on the utilization of the limited deposits of iron pyrites for the same purpose has also been actively pursued. Work on the preparation

of activated carbon from groundnut hulls, potassic fertilizers, activated silica and white cement from feldspar, and phosphatic fertilizers from bone meal have given encouraging results.

The *Ceramic Section* has aimed at the utilization of indigenous raw materials. Systematic studies of Hyderabad clays, including X-ray and base-exchange studies, have been carried out. The methods of manufacture of sand-lime and clinker-lime bricks, insulator bodies, insulator bricks, whiteware bodies and fire-clay refractories have been investigated.

The *Physical Chemistry and X-ray Section* has carried out valuable X-ray studies on the nature of Hyderabad clays and is at present engaged in X-ray studies of other clays and of monazite sand. The section is equipped with modern types of instruments such as ultra-violet spectrographs, petrological microscope, metallographic equipment, etc.

The *Oils Section* has been engaged in extensive studies on sitaphal seed; on cotton-seed (storage of seed, composition of seed and oil, refining of oil and utilization of foots), and on castor oil (detailed investigations on dehydration, isolation of the valuable lubricant triricinolein). Katha (acacetidin) has been found to be an excellent anti-oxidant for edible oils. Methods of fractional separation of fatty acids using urea adducts have been extensively investigated. Several local fuller's earths and clays have shown valuable bleaching properties, and large-scale trials are in progress.

The *Biochemistry Section* has carried out extensive studies on the utilization of molasses, and has aimed at the production of citric acid (using strains of *Aspergillus niger*), lactic acid and calcium lactate, food yeast, and levulinic acid and its salts. Selected strains of *Aspergillus terreus* have been employed for the production of itaconic acid from glucose and sucrose. The protein and non-protein nitrogenous constituents of the seed cake of *Annona squamosa* are also being investigated.

The *Organic Chemistry, Pharmaceuticals and Drugs Section* is working on both natural and synthetic products. Quinazoline-type compounds with potential analgesic activity have been prepared, a new synthesis of pethidine attempted and encouraging results have been obtained in a scheme for the simpler synthesis of diethylstilboestrol. Studies have been carried out on the preparation of strychnine from nux vomica. The fundamental constituents of Indian turpentine are being re-investigated, while chlorinated turpentines have shown outstanding insecticidal activity. The preparation of vanillin from the lignin obtained from paper-mill black liquor has been attempted, and pure geraniol has been prepared from palmarosa oil.

The *Paper and Fibre Section* has been investigating the production of hand-made paper for different purposes, for example, bond, drawing, writing and filter papers, utilizing locally available raw materials. In view of the existence of an acetate-rayon factory in the State, this section has been actively investigating the various cellulosic materials as raw materials for rayon manufacture.

The *Entomology Section* has been testing the insecticidal efficiency of various products prepared in the Laboratories.

The *Chemical Engineering Section* is associated with all pilot-plant schemes of the Laboratories and with the procurement and setting up of equipment. The section has been carrying out extensive studies

on solvent extraction of oil-cakes. It also advises the regional industries in their chemical engineering problems, in addition to helping them in the erection and operation of their manufacturing plants. It has been responsible for erecting the Lurgi plant for low-temperature carbonization of coal and a complete Carver pilot-plant for pretreatment of cotton-seed. The chemical engineering aspects of processes worked out in the Laboratories, such as production of levulinic acid from molasses, of fructose from cane sugar, of itaconic acid from sucrose, of dehydrated castor oil, briquetting of coal, fluidization of coal, fractionation of fuel oil, hand-made paper, refining of palmarosa oil, activation of Hyderabad earths, etc., have been engaging the attention of this section.

The staff comprises the director of the Laboratories (Dr. S. Husain Zaheer), two assistant directors (Dr. S. A. Saletore, one vacancy), 53 scientific officers and research assistants and 52 technical staff.

Reports and Finance

During the years 1950-53, fifty-three papers were published by the Laboratories staff, twelve were communicated for publication, 187 papers were read at various symposia and conferences, seventeen patents were obtained and two patents are pending grant.

The Laboratories organized symposia on fuels, fats and oils and on research and industry in 1950, and later published the proceedings.

Annual reports (since 1950) are published regularly, giving summaries of the items of work under investigation.

The Laboratories strive to maintain close relations with other research institutions in India and abroad, and with industries. Regular visits by members of the staff are paid to various factories; for example, to the Nizam sugar factory, Sirpur paper mills, Sirpur acetate-rayon plant, Singareni collieries, ceramic and glass factories, vegetable oil factories, chemical and biochemical manufactories. Advice is given on both short-term and long-term problems.

The recurring budget of the Laboratories for 1947-48 stood at Rs. 2.74 lakhs; for 1953-54 it is Rs. 4.5 lakhs.

The non-recurring grants actually made available over the past five years include the following:

	Rs.
(a) Building	
From the Government of Hyderabad	16.7 lakhs
From the Government of India	5.0 "
(b) Equipment	
From the Government of Hyderabad	7.1 "
(c) Pilot-plant projects	
Grants from the Industrial Trust Fund, Hyderabad	
Low-temperature carbonization plant	7.5 "
Chemical engineering equipment	2.6 "
Cotton-seed processing plant	1.0 "
(d) Research schemes	
Coal survey	
Grants from the I.T.F., Hyderabad	12,000
Grant from the C.S.I.R., Delhi	22,000
X-ray studies on Indian clays	
Grant from the C.S.I.R., Delhi	6,000
Grant from the Atomic Energy Commission	5,000
Briquetting of non-caking coals	
Grant from the C.S.I.R., Delhi	7,000

A sum of Rs. 1 lakh was given to the Laboratories in 1953 by the Azamjahi and Osmanshahi Mills, Ltd., Hyderabad. This was further augmented by smaller donations of a total value of Rs. 15,800 from other industries. The interest from these sums is being used for instituting research scholarships. Under the five-year plan Rs. 27 lakhs have been sanctioned to the Laboratories but have not yet been made available.

OBITUARIES

Prof. A. G. Ogilvie, O.B.E.

THE sudden death of Alan Grant Ogilvie, who collapsed while attending a meeting of the Royal Scottish Geographical Society on the evening of February 9, takes from our midst one of the few remaining pioneers of the new geography as a university discipline. Born in Edinburgh in 1887, he maintained throughout his life much of the dignity and Victorian charm characterizing his childhood home—the son of a distinguished if austere father, the late Sir Francis Ogilvie. From George Watson's College and Westminster School, he proceeded to Magdalen College, Oxford, taking his B.A. in 1909. Periods of study at the Geographical Institute of the University of Berlin and at the Sorbonne followed, and gave him a command of European languages and a wide range of academic contacts—further extended by geological studies at the Imperial College of Science and Technology, London.

His academic career began in 1912 when he was appointed junior demonstrator in geography at Oxford but was interrupted by the outbreak of war in 1914. Ogilvie had accepted a commission in the 7th London Brigade of the R.F.A. in 1911, so he was immediately called up and served in France, the Dardanelles and Salonika before becoming staff captain at the War Office in 1918. His selection as leader of the Geographical Section of the British Peace Delegation at Versailles was an obvious one. It was there that he began a lasting friendship with Isaiah Bowman, leader of the American Geographical Section. It was often difficult for the few experts present to hide the sometimes abysmal ignorance of the peace-makers concerning the countries and peoples for whom they were legislating. There is no doubt that the state of affairs thus revealed stimulated the establishment of Honours Schools of Geography in most British universities in the decade which followed. Ogilvie was made O.B.E. for his services and was appointed reader in geography at Manchester. The following year, however, Bowman, then director of the American Geographical Society, invited him to New York, and during 1920–23 he was head of the Hispanic American Division of the Society. There he showed his flair for collating work from many and varied sources, evidenced first by his "Geography of the Central Andes" (1922). In 1923 he returned to his native Edinburgh, there to spend the rest of his life, first as lecturer, then as reader (1924) and finally as professor of geography from 1931 until his death.

Ogilvie's writings were neither numerous nor voluminous, but always scholarly and showing evidence of very wide reading. His work as editor and part author of "Great Britain", a series of regional essays prepared for the International Geographical Congress in 1928, remains of lasting value. He served devotedly the Royal Scottish Geographical Society (honorary secretary, 1925–41; president, 1946–50) as well as the British Association (president, Section E, 1934; chairman of Committee on Tropical Africa), the Institute of British Geographers (president, 1951–52) and the International Geographical Union (section president, Lisbon, 1949).

A man of great intellectual integrity himself and not always robust physically, he refused to condone lower standards in others, and perhaps envied the

greater facilities for field-work and research enjoyed by the younger academic men of to-day. To them he sometimes appeared austere and even intolerant, but many grew later to know him as a sincere friend. His solid Edinburgh home meant much to him, and he felt very deeply the recent loss of his wife after a trying illness. He himself will be greatly missed.

L. DUDLEY STAMP

Mr. David Milne, C.I.E.

MR. DAVID MILNE, who died recently, was one of the fast-dwindling members of the Indian Agricultural Service, which was started about 1903 and the members of which by their devoted labours did so much to improve agriculture in India and from which she is now reaping the benefit.

Born in Scotland in 1876, Milne was educated in the University of Aberdeen, where he took his degree in science. His first appointment was to Egypt, where he was agricultural chemist to the Corporation of West Egypt, and when, no doubt, he made his first contact with cotton, a crop with which he was intimately concerned for the remainder of his career.

In 1907 he joined the Indian Agricultural Service and was posted to the Punjab as economic botanist, a post he held until 1921, when he became principal of the Lyallpur Agricultural College. In 1922, however, he was promoted to be director of agriculture, Punjab, and held this important post until his retirement in 1933, being made C.I.E.

The name of Milne will long be remembered in the Punjab and India for his work in selecting new types of long-staple cotton. The climate of the irrigated areas of the Punjab present certain peculiarities, and the type of plant has to be selected to meet these conditions. After the First World War, there was a shortage of long-staple cotton, and the demand for cotton of the Middling American standard, and even a little longer in staple, was strong both from the Bombay mills as well as from Lancashire. Prior to his arrival, attempts to introduce seed direct from the United States had met with little success, for these varieties failed to thrive under Punjab conditions, and although they obtained a premium on quality, they failed to find popular favour because their yields were very much smaller than the short-stapled Deehi, a native Indian type. By applying modern methods of plant breeding, Milne evolved new varieties of American upland-type cotton which not only withstood jassid and other pests but also gave yields approximating to those given by the native types. The first of these cottons was a variety called 4 F, and it was replaced by a variety with a somewhat longer staple, 284 F, and other selections followed. As a result of his work, American upland cottons of long staple came to be cultivated over very large areas in the Punjab and Sind and did much to meet the demand of the Indian mills.

Although most of his scientific work was applied to cotton, he found time to study other crops as well, and made a detailed study of the possibilities of cultivation of date palm in the Punjab. His "Handbook of Field and Garden Crops in the Punjab" also proved of great value in teaching establishments.

Milne became a member of the Indian Central Cotton Committee and was also on the Council for Agricultural Research in India from 1928 until his retirement in 1933.

G. EVANS

NEWS and VIEWS

Chemistry at King's College, Newcastle upon Tyne (University of Durham):

Prof. W. F. K. Wynne-Jones

ON the retirement of Prof. G. R. Clemo, who has been director of the Chemical Laboratories at King's College, Newcastle upon Tyne, since 1932, Prof. W. F. K. Wynne-Jones becomes professor of chemistry and head of the Chemistry Department. Prof. Wynne-Jones, who was appointed to the chair of physical chemistry in the College in 1947, has carried out distinguished work in the field of chemical kinetics (see *Nature*, 160, 291; 1947).

Organic Chemistry: Prof. G. R. Clemo, F.R.S.

PROF. G. R. CLEMO retires at the end of this session from the chair of organic chemistry at King's College, Newcastle upon Tyne, which he has occupied since 1925. Clemo received his early training at University College, Exeter, and, after a period as science master at Penzance, he went to the Queen's College, Oxford, to work under Dr. Chattaway. His experimental skill was used to the full during the First World War, when he worked in a team under Prof. W. H. Perkin on the synthesis of dyestuffs which were urgently needed because the industry had been allowed to lapse in Britain, whereas it was extensively developed in Germany. In the years immediately following the War he continued to work under Perkin and was a well-known figure in the Dyson Perrins Laboratories at Oxford. In 1924 Clemo was appointed director of the research laboratories of the British Dyestuffs Corporation at Manchester, a post which he relinquished on his appointment to the chair of organic chemistry at Armstrong College (now King's College, Newcastle upon Tyne). His tenure of the chair has been marked by considerable productivity and by the growth of the Department to its present high position in the chemical world. Clemo in his own work has been an outstanding disciple of Baeyer and Perkin, and, while his interests have ranged over the whole field of natural products, he has contributed particularly to an understanding of the lupin alkaloids. He and his associates have also synthesized anti-malarials related to quinine, and in recent years Clemo has been studying the little-known alkaloid tazettine isolated from snowdrops, and has directed his attention to the widespread black pigment, melanin. Throughout his career Clemo has been devoted to the laboratory bench, and has set an example of personal industry which has stimulated his associates.

Prof. F. S. Spring, F.R.S.

PROF. F. S. SPRING, who is to succeed Prof. Clemo, was educated at Waterloo Grammar School and in the University of Liverpool, where he began research work under Prof. I. M. Heilbron. In 1930 Spring went as assistant lecturer to the University of Manchester, and had attained the position of senior lecturer when he left in 1946 on his appointment as Freeland professor of chemistry in the Royal Technical College, Glasgow. In his association with Prof. Heilbron as pupil and collaborator, Spring carried out an extensive and an impressive study of the chemistry of the sterols. Since going to Glasgow, he has built up a flourishing school of organic chemistry which has made important contributions to the

chemistry of the steroid and triterpenoid groups of chemical substances. In this study they have succeeded in isolating triterpenoids of unusual structure from *Strychnos nux-vomica* and from opium. Spring's work has led him to close association with the medical aspects of organic chemistry, and he has been investigating possibilities in the synthesis of cortisone as well as the possible relationship of steroid metabolism to arthritis. Spring has shown himself a master of experimental method and an original investigator: his enthusiasm and energy combined with his clear insight into problems of organic chemistry ensure that the development of this subject will continue in Newcastle.

Directorship of the Bermuda Biological Station:

Dr. L. W. Hutchins

DR. LOUIS W. HUTCHINS has been forced by ill-health to retire from the directorship of the Bermuda Biological Station, in which capacity he has served since 1949. Dr. Hutchins is a graduate of Yale University, receiving his doctorate in zoology in 1941, and was Mary S. Muellhaupt Scholar at Ohio State University during 1941-42. He then became associated with the Woods Hole Oceanographic Institution in connexion with investigations being made for the United States Navy on the prevention of marine fouling, and he contributed several chapters to a monograph on "The Prevention of Marine Fouling", prepared by the Woods Hole Oceanographic Institution for the Navy. Dr. Hutchins is a specialist on the salt-water Bryozoa and has made important contributions to the interpretation of temperature zonation in geographical distribution. He is now an associate on the staff of the Woods Hole Oceanographic Institution.

The Bermuda Station was founded in 1901 by Dr. E. L. Mark, of Harvard University, for the scientific study of biology. When it was reorganized and incorporated in 1931, it received an endowment from the Rockefeller Foundation to permit it to function also as an oceanographic station, for which its location is admirable. Dr. Hutchins was well fitted to develop this part of its activities, and he immediately initiated a general oceanographic programme for working out the economy of the waters inside the fringing reefs and their relationships with the ocean water outside.

Dr. W. H. Sutcliffe, Jun.

DR. WILLIAM H. SUTCLIFFE, JUN., who has been appointed to succeed Dr. Hutchins at the Bermuda Biological Station, has served as staff biologist at the Station since 1951 and is consequently well acquainted with the local situation and the fauna of the islands. A native of Florida, he was educated at Emory University and at Duke University, where he was granted his doctor's degree in 1950 for studies in marine ecology. Prior to going to Bermuda, he worked at the Institute of Fisheries Research of the University of North Carolina, where he conducted research on zooplankton and on the commercially important shrimp of Carolina waters. At Bermuda he has been investigating the biology of the spiny lobster, *Panulirus guttatus*, on behalf of the Bermudan Government. He has published papers on the taxonomy of the calanoid copepods of North Carolina waters and on the breeding and migration of the spiny lobster. Dr. Sutcliffe brings to his task as director experience in the application of oceanography to fishery problems. His pre-

decessor organized an oceanic fisheries conference in Bermuda during 1951, at which the prospects for taking fish from the open and deep ocean—a difficult problem—were explored. An outcome of this was the provision by the Bermudan Government of a research vessel for ocean work, which should enable valuable fishery investigations to be undertaken.

Institution of Civil Engineers' Secretaryship: Mr. E. Graham Clark, C.B.E.

WHEN he retires this year on reaching the age of sixty-five, Mr. E. Graham Clark, secretary of the Institution of Civil Engineers, will have completed thirty-five years on the permanent staff of the Institution. A graduate of the University of Durham, he had spent four years as a pupil and assistant engineer before the First World War took him into the 50th (Northumbrian) Division, Territorial Forces. He was awarded the Military Cross, and on his return home in 1919 joined the staff of the Institution of Civil Engineers as chief technical assistant. He later became chief assistant to the secretary, Dr. H. H. Jeffcott. After a period as acting secretary in 1937, Mr. Clark was chosen to succeed him. Only those who have worked closely with Mr. Clark know how loyally and enthusiastically he has striven to advance the prestige and usefulness of the Institution. He leaves an Institution which has greatly developed in character and influence during his years of office. Before his time, there were no special divisions of the Institution, no Colonial Engineering Conference and no international associations of engineering societies. The local associations and the associate members of the Institution were not represented on the Council. Institution meetings were relatively few and the publications far less comprehensive than to-day. The bringing together of the three major engineering institutions of Britain, the Civils, the Mechanicals and the Electricals, to work in close collaboration has been one of Mr. Clark's noteworthy achievements. This rapprochement was soon followed by the formation of the Conference of Representatives from the Engineering Societies of Western Europe and the United States of America and the Conference of Engineering Institutions of the British Commonwealth. He has played a leading part both in their inception and in the conduct of their business. Mr. Clark was honoured for his services to engineering by being created C.B.E. in 1948, and by the award of an honorary M.Sc. of the University of Durham in 1953.

Mr. Alexander McDonald

IN succeeding Mr. Graham Clark as secretary of the Institution of Civil Engineers, Mr. Alexander McDonald will be undertaking a task which has no equal in service to the civil engineering profession. A graduate of the University of Edinburgh, he entered the Nigerian Engineering Service after practical training in Britain. At the age of fifty, Mr. McDonald has completed more than twenty-five years service in Nigeria and has risen to become the Inspector-General of Works—the head of the Public Works Department—a post which he has held with distinction during the past three years of active political change in that country. He brings to his new task a wide and varied experience of civil engineering ranging from water supply to airfield construction, and has studied highway engineering in the United States. He has contributed two papers to the Institution. He has always shown a keen

interest in the affairs of the Institution, and it was to satisfy his desire for the Institution to play a greater part in the life of the Colonial engineer that the Colonial Engineering Conference, now held biennially, was instituted; he was also the moving spirit in forming the West African Joint Branch of the three Institutions and is its first chairman.

Verband Deutscher Physikalischer Gesellschaften

WITH the close of hostilities in 1945 the Deutsche Physikalische Gesellschaft and the Deutsche Gesellschaft für Technische Physik ceased to function; later, in their place, there was founded the Verband Deutscher Physikalischer Gesellschaften, made up of the following five organizations: Physikalische Gesellschaft in Bayern, Physikalische Gesellschaft zu Berlin, Physikalische Gesellschaft Hessen-Mittelrhein, Nordwestdeutsche Physikalische Gesellschaft, and Physikalische Gesellschaft in Württemberg-Baden-Pfalz. At a meeting of the Verband in Innsbruck last September it was decided that amends should be made to all former members of the two original German physical societies whose names were removed, for political or other reasons, from the societies' rolls. There are many such persons, mostly living outside Germany, and an attempt has been made to get into touch with each one by letter and invite him to join the new organization. Unfortunately, in many cases it has not been possible to find out whether a particular person is still alive and, if so, what is his address; consequently, an open invitation is now being extended to all such victims of the Nazi persecution to join the Verband Deutscher Physikalischer Gesellschaften. All those interested or anyone who can give information regarding the whereabouts of any former member should write to the Verband at Scheffelstrasse 2, Heidelberg.

Visas to the United States for Scientific Workers

A NEW survey of the effects of the present immigration legislation in the United States on issuing visas to foreign scientific workers is now being made by the Federation of American Scientists. The Federation wishes to be informed, with as many details as possible, of any case during the past two years in which a scientific worker was refused a visa or in which the issue of his visa was delayed so long that his projected visit to the United States had to be cancelled. All information will be treated confidentially, and no information will be made public without the written consent of the person involved. The Federation is of the opinion that, if the present restrictive provisions on visas to the United States are to be amended, it will be necessary for the American public and Congress to be convinced of the inadequacy of the present law. This can be accomplished only by assembling information which shows the adverse effects of the present visa policy, and the co-operation of foreign scientists in this matter is therefore essential. Information should be sent to the Committee on Visa Problems, Federation of American Scientists, 1749 L Street, N.W., Washington 6, D.C.

M. and B. Laboratory Bulletin

THE first number of the *M. and B. Laboratory Bulletin*, a new venture of May and Baker, the well-known manufacturers of chemical reagents, was published in January, and further issues are promised from time to time (obtainable free from May and

Baker, Ltd., Dagenham, Essex). This number is a well-printed, well-illustrated, folio-sized booklet of twelve pages. The promoters intend to furnish information on apparatus, reagents and techniques from the work in their own laboratories, and on matters of interest to chemists generally. There is also a hint of forthcoming articles of wide cultural appeal by outside contributors. The editors have certainly in this first number set themselves a good model and produced a well-balanced journal. The articles, all by specialists, are entitled: petroleum; a gas-scrubbing tower; potassium borohydride; and in a secondary modern school. To complete the contents, there are four abstracts, illustrated and in smaller type, which deal with the contents of a bottle; a semi-micro ozonizer; the handling of sodium; and the distillation of mercury. Each of the articles is intended to be the first of a series discussing severally the industrial production of chemicals, industrial apparatus, new reagents, and the teaching of chemistry. The inclusion of the last feature shows that thought and vision have gone to the planning of the *Bulletin*. For, manifestly, the promoters realize that in these days of the industrial importance of chemistry its teaching is of vital significance.

Composite Wood

THE term 'composite wood' is not perhaps very widely known, and the editor of the new journal, *Composite Wood* (1, No. 1; October 1953. From 15 Beeson Road, New Forest P.O., Dehra Dun, U.P., India; price Rs. 2.8), has wisely set out on the title page his aims combined with a definition of the subject "... to promote the study and practice of the science and technology of composite wood (adhesives, plywood, laminated and other improved woods, building boards, etc.), and allied subjects". The journal is a welcome addition to the very few devoted entirely to the technical aspect of composite wood matters, and should be of value to the plywood and allied industries, which are now established in all parts of the world. The editor, Dr. D. Narayana-murti, is in charge of the Composite Wood Branch of the Forest Research Institute, Dehra Dun, and he and his associates have contributed extensively to this first number. The inclusion of an article by Dr. F. Kollmann, of Germany, however, indicates the international aims of the journal. In addition to four technical papers, under "Notes and News" are information on meetings of specialist societies, details of forthcoming specifications, and references to manufacturers' publications on new adhesives. The abstracts deal fully with papers bearing on composite wood, and, in the present issue, two books are reviewed. It is understood that the journal will be published every two or three months.

Maps of Africa South of the Sahara

A LIST of "Maps of Africa South of the Sahara" has been compiled and published by the Scientific Council for Africa South of the Sahara (Publication No. 4; pp. ii+122; from the Council, Bukuru, Belgian Congo, 1953; 15 francs). The list attempts to show the position in 1953. Historical maps have been excluded and so also have maps on a scale smaller than 1 : 1,000,000. Atlases are listed, but their contents are not detailed in broad terms. Maps of special subjects are included, such as geology, climate, vegetation and population. The mapping of Africa is advancing at a great rate, and there are few areas

that have no maps. Every entry gives the scale and source of publication.

Molluscan Adaptation

THE shell, mantle and organs in the mantle cavity of the characteristic *Pinna carnea* have been investigated in detail with special regard to their adaptation to the peculiar mode of life of this mollusc by C. M. Yonge (*Phil. Trans. Roy. Soc. Lond.*, B, No. 648; 1953). The shell, the shape of which recalls a partially opened fan, in the living animal is found with the pointed end embedded in the substratum with half its length, that is, considerably more than half its area, projecting freely upwards. This allows the inhalant current with its contained food particles to be drawn from clean water above the bottom and, conversely, the exhalant stream does not disturb the mud. However, standing upright and having free mantle lobes, the animal must be liable to a certain amount of silting, particularly when the surrounding mud is disturbed. We therefore find that it produces a strong exhalant current and that it has a special, powerfully ciliated waste canal wall provided with mucous glands, which plays an important part in removing silt and the pseudofeces. Such a projecting shell, incapable of withdrawing, is liable to injury and the mantle is highly retractable and not attached to the part of the shell that is exposed, so that it can be withdrawn to escape injury. It can quickly carry out repairs, but it follows from its limited attachment that the shell in its projecting area is composed of the prismatic layer only. This layer is, as usual, constituted by a concholin network impregnated with calcite crystals arranged in prisms. There is a very much higher proportion of organic matter than in most molluscs, so that the projecting part of the shell is flexible and hence less liable to breakage. The Pinnidae alone possess a pallial organ, a large unpaired tentacular structure, the function of which appears to be that of clearing away the broken pieces of shell.

Chemical Basis of Resistance to Fungal Attack

THE nature of the resistance of oats to *Ophiobolus graminis* has been investigated by E. M. Turner by testing the reactions of two varieties of the fungus to the sap (*J. Exp. Bot.*, 4, 264; 1953). The two varieties of the take-all fungus, *Ophiobolus graminis* and *O. graminis* var. *avenae*, show a differential reaction to sap extracted from oats; the type variety, which is incapable of causing a lasting infection of oats *in vivo*, is inhibited by the sap *in vitro*, whereas var. *avenae*, pathogenic to oats, can grow in the sap. The inhibitory action of the sap is not due to a lack of food material required by the fungus, but to a specific substance or toxin. The method used for assaying toxicity is described. The inhibitor is produced in considerable quantity in the leaves and stems of oats and in smaller quantity in the roots. It appears to accumulate mainly during the period of active growth and to be less active, or present in smaller concentration, in adult plants. It can be detected in the seminal roots throughout their existence, although during the first three weeks of growth *O. graminis* can invade the cells of the cortex. It is present in greater quantity in the crown roots, which are never penetrated. A similar inhibitor of *O. graminis* can be extracted from *Arrhenatherum elatius*, but not from other grasses which, both in the field and in pot experiments, appear to be equally resistant.

Rouelle and Chemistry In France

AN interesting paper in *Endeavour* (July 1953) by Dr. Douglas McKie deals with Guillaume-François Rouelle (1703-70), demonstrator in chemistry at the Jardin du Roi in Paris, and the teacher of Lavoisier and Diderot. He discusses a set of notes of Rouelle's lectures belonging to the Science Library of Clifton College, and there is a coloured reproduction of a miniature of Rouelle, also in Clifton College. Dr. McKie points out the important role which Rouelle took in the development of French chemistry; but in saying that it was he who introduced the phlogiston theory into France, Dr. McKie seems to overlook the account of the theory contained in a two-volume book 'Nouveau Cours de Chymie, suivant les Principes de Newton & de Sthall', published in Paris in 1723, at a time when, Dr. McKie says, Rouelle was still a student.

Watsonia: a Journal of British Botany

BEGINNING with the first part of Vol. 3 (published December 1953), *Watsonia, The Journal of the Botanical Society of the British Isles*, now appears in the format of most important scientific journals (obtainable from the Department of Botany, British Museum (Natural History), London; 7s. 6d. per part). The aim of this journal is to provide a medium for the publication of original work on the taxonomy and distribution of flowering plants, vascular cryptogams and charophytes in the British Isles. Included in the present part are contributions relating to *Montia fontana*, *Nuphar intermedia* (a presumed relict hybrid), regional variation in *Alnus glutinosa*, Arctic plants not yet found in Britain, the distribution of *Dryopteris Borreri*, and notes on *Carex flacca*.

Careers In Agricultural Research

A USEFUL pamphlet entitled "Careers in Agricultural Research—Training Grants, Studentships and Fellowships awarded by the Agricultural Research Council, 1954" has recently been issued by the Agricultural Research Council. There are openings for research workers in many of the twenty-six agricultural research institutes financed by the State. In addition, certain appointments in universities and other research institutions are financed by the Council; many of these are temporary in character, but are particularly attractive to the young worker who wishes to work under the personal guidance of a distinguished scientist. The pamphlet also gives useful information about the scientific staffs of the Council and of the State-aided agricultural research institutes, and about the advisory services. This year the Council is again offering two veterinary clinical fellowships to provide opportunities for suitably qualified veterinary clinicians and pathologists of Ph.D. standing to continue research for two or three years. The fellowships will be renewable annually up to a maximum of three years and will carry a stipend of £850 a year. In addition, the Council is continuing to offer a limited number of junior agricultural research fellowships, carrying a stipend of £630 a year, to research workers of outstanding ability; and a larger number of postgraduate training grants and research studentships in agricultural and veterinary science. Applications for awards should reach the Council by March 20. Further information and a copy of the pamphlet can be obtained on application to the Secretary, Agricultural Research Council, Cunard Building, 15 Regent Street, London, S.W.1.

Postgraduate Agricultural Scholarships

THE three Agricultural Departments of the United Kingdom have been allocated £625,000 over the next three years from the general allotment of Counterpart Funds given by the United States to Great Britain and other European countries for increasing productivity. It has now been announced that £25,000 of this sum will be devoted to postgraduate scholarships, the distribution being England and Wales, £15,000; Scotland, £5,000; and Northern Ireland, £5,000. In England and Wales the scholarships will be awarded in the following subjects, the qualifications required being considerably higher than for ordinary postgraduate scholarships: agricultural economics; farm management; estate management; and land economics and land use. Their value will be £400-£800 a year free of income tax plus all compulsory fees, authorized travelling expenses and a book allowance not exceeding £10 a year. Further information and application forms can be obtained from the Secretary, Ministry of Agriculture and Fisheries, 1-4 Cambridge Terrace, Regent's Park, London, N.W.1.

Australian and United Kingdom Postgraduate Research Studentships tenable in Australia

TO assist in the movement of scientists between various parts of the British Commonwealth, the Australian Commonwealth Scientific and Industrial Research Organization and the Department of Scientific and Industrial Research and the Agricultural Research Council of Great Britain are collaborating in an arrangement for providing a limited number of postgraduate research studentships tenable at Australian universities or other approved Australian research institutes. Under the arrangement, an allowance of £A800 a year and other approved expenses in Australia will be made by the Commonwealth Scientific and Industrial Research Organization, and the Department of Scientific and Industrial Research or the Agricultural Research Council, as may be appropriate, will pay travelling expenses to and from Australia. Candidates must be honours graduates in science or agriculture, and must be British subjects normally resident in the United Kingdom. The awards will be tenable for two full years in Australia. Full details regarding the conditions of the studentships are being made available to all departments of the natural sciences and agriculture in universities in the United Kingdom and to technical colleges and polytechnics.

Sixth Commonwealth Entomological Conference, London

THE sixth Commonwealth Entomological Conference will be held in London during July 7-16, and will be organized by the Commonwealth Institute of Entomology, London. Delegates to the Conference are being nominated by the Governments of the various countries of the British Commonwealth, including many of the Colonial Territories. In addition to the business meetings, which will be attended only by delegates, there will be open meetings on July 8, 9, 12, 13 and 15, at which subjects of wide interest to economic entomologists will be discussed. These open meetings will commence with short papers, read by invitation, the subjects being as follows: recent developments in the use of insecticides on field crops and against

locusts and tsetse flies; the effect of insecticides and other chemicals on the balance of animal populations; the development of resistance to insecticides; the estimation of losses from pests; the biological control of insects and weeds; the supply and training of insect taxonomists; pests of tropical cereal crops; developments in work on pests of stored products; problems of forest entomology; developments in termite research; recent developments in research and control of locusts and of tsetse flies. A report of the Conference will be published by the Commonwealth Institute of Entomology and will include reviews of the progress of economic entomology made by the Commonwealth countries during the six years elapsed since the last Conference. Programmes giving full details will be available about four weeks before the Conference from the Director, Commonwealth Institute of Entomology, 41 Queen's Gate, London, S.W.7, to whom all inquiries should be sent.

Development of the Mammalian Embryo: Cold Spring Harbor Symposium

THE nineteenth Cold Spring Harbor Symposium on Quantitative Biology will be held during June 7-14, when the topic of "The Mammalian Foetus—Physiological Aspects of Development" will be discussed. The primary function of the symposium will be to evaluate the principal morphological, physiological and biochemical factors that are essential for the immediate well-being and future development of the mammalian embryo. This will involve a consideration of hereditary-foetal and maternal-foetal relationships, as well as of the development and function of the membranes, decidua and trophoblast of the conceptus. Attention will be focused on the homeostatic factors that contribute to normal somatic and visceral development of the embryo to meet the requirements of living before, during and just after birth. Twenty-four of the participants will come from European countries, including Belgium, Finland, France, Great Britain, Ireland, Netherlands, Norway, Sweden and Switzerland. The Symposium is being sponsored by the Carnegie Corporation of New York, the National Science Foundation, and the Association for the Aid of Crippled Children. The programme and any further information can be obtained from the Biological Laboratory, Cold Spring Harbor, New York.

International Photobiological Congress In Amsterdam

THE Comité International de Photobiologie (C.I.P.), known before 1951 as the Comité International de la Lumière, will be holding an international congress in Amsterdam during August 23-28, 1954, organized by the Netherlands Committee on Photobiology. The aims of the Committee are the stimulation of scientific research in the physics, chemistry and climatology of ultra-violet, visible and infra-red radiations as they pertain to biology, and the study of the effects and applications of these radiations in biology and medicine. The congress will review the present state of knowledge in certain important fields of photobiological investigation, pure and applied, and will provide a forum for the presentation of new researches; to this end three symposia will be held, with the chairman shown, as follows: photoperiodism in plants and animals (Dr. R. van der Veen, Eindhoven); the effects of ultra-violet radiation on

genetic elements of cells (Dr. R. Latarjet, Paris); and the fundamental effects of light on the skin (Prof. James Hardy, Philadelphia). In addition, it is planned to have reports on photopathology, phototherapy and on methods for the measurement of radiation. The three languages of the Congress will be English, French and German. Persons wishing to attend the congress should write as soon as possible to the Secretariate Congress C.I.P., Radiologisch Laboratorium, Wilhelminagasthuis, Amsterdam.

European Congress on Clinical Chemistry

THE first European Congress on Clinical Chemistry will be held in Amsterdam during September 23-28 (Royal Institute for the Tropics, 63 Mauritskade, Amsterdam-O), under the auspices of the Commission on Clinical Chemistry of the International Union of Pure and Applied Chemistry, and will be organized by the Netherlands Society for Clinical Chemistry. The two leading subjects will be: isotopes in the clinico-chemical laboratory; and physical methods of measurement in connexion with clinico-chemical problems. These subjects will be presented in symposia, made up partly of lectures given by invited speakers and partly of free communications, for which a maximum of fifteen minutes will be allowed. Those who wish to read a communication should send in their papers, accompanied by a summary of 100-150 words, to the secretary of the Congress, Ir. O. Meulemans, Racineaan 17, Utrecht, before April 1. Excursions to various institutes and laboratories and also to places of interest in the Netherlands are being planned. The fee for the Congress is full members 25 florins (about £2 7s.) and those accompanying members 10 florins.

Announcements

PROF. J. K. CHARLESWORTH, Department of Geology, The Queen's University, Belfast, has been awarded the Neill Prize for 1951-53 of the Royal Society of Edinburgh for his work on the glaciology of Scotland and his other valuable contributions to geology.

THE American Association of Scientific Workers is to celebrate Prof. Albert Einstein's seventy-fifth birthday on March 14. The celebration is designed to emphasize his contributions as a great scientist, humanitarian and defender of human rights and liberties.

THE Royal Dutch-Shell Group of Oil Companies is offering a research studentship in geophysics of value £450 a year (£500 for married men) and tenable for two to three years at the University of Cambridge, which is open to men of any nationality less than twenty-seven years old. Further information can be obtained from Mr. B. C. Browne, Department of Geodesy and Geophysics, Downing Place, Cambridge, to whom application must be made by July 1.

Two Ramsay Memorial Fellowships, worth £400 a year plus a grant for expenses not exceeding £100 a year, are being offered for chemical research; they will normally be tenable for two years. One of the Fellowships will be limited to candidates educated in Glasgow. Further information can be obtained from the Joint Honorary Secretaries, Ramsay Memorial Fellowships Trust, University College, Gower Street, London, W.C.1, to whom application forms must be sent not later than April 21.

BRITISH IRON AND STEEL RESEARCH ASSOCIATION WORK AT SHEFFIELD LABORATORIES

THE laboratories of the British Iron and Steel Research Association in Sheffield, which have recently been opened, have been built to provide laboratory and plant facilities for three of the Association's five divisions—those concerned with steelmaking, metal-working and metallurgy.

They have been planned in part to overcome a difficulty met with in much industrial research and particularly in that connected with the iron and steel industry. This is the very great difference in scale between laboratory bench-work and industrial-plant operations, which tends to make experiment on operating plant extremely expensive and diminishes the value of much preliminary work.

In addition to the more usual research facilities and offices, therefore, there are at Sheffield two so-called 'plant laboratories' in which experiments not far removed from the scale of steelworks operations can be carried out. They contain, in particular, an electric arc furnace, a rolling mill, a forging press and a high-speed wire-drawing machine. The plant laboratories are single-story buildings of 10,000 sq. ft. and 4,000 sq. ft. floor area respectively. There is a third new building, a three-story main block of approximately 30,000 sq. ft. floor area. There are also four buildings which were previously on the site, one of which is occupied by the Cutlery Research Council, an independent body which makes use of the Association's central administrative services, and works in close liaison with the three divisions of the Association.

Steelmaking Division

The Steelmaking Division is naturally concerned particularly with fuel efficiency, and carries out many field-trials and observations on industrial furnaces. Fairly recent extensions concern the measurement of flame heating-power and its relationship to changes in furnace-operating conditions. This is an attempt to apply in steelworks practice the results of the work of the International Flame Radiation Committee on the experimental furnace at Ijmuiden.

One of the Ijmuiden results requiring further study is that steam reduces flame-radiating power, yet an increase in steam/oil ratio is known to give faster melting in many furnaces. This may be due to several combined effects; for example, increase of steam will increase the momentum of the jet, and may therefore increase the convective heat transfer, which is known to be very important during the melting-down stage.

Other field-work related to fuel efficiency is that concerned with the infiltration of cold air in open-hearth furnaces. Two techniques of measuring the air or gas flow in the flue system of such furnaces have been developed. The first was based on Pitot tube surveys across sections of the system, which proved not to be of general application because many furnaces have no suitable location for Pitot tube measurements. In the second technique, therefore, radon was injected into, and traced through, the system. This technique is applicable to all furnaces, and permits a much more detailed survey to be made of the flow in furnace systems, including leakages at valves. Investigations of flow are usually accompanied by temperature measurements of the preheated air supply. The many instruments such

as suction pyrometers, radon tracer and various calibration equipments needed for this field of work are kept at the Association's Sheffield laboratories ready for use at member firms' works.

Work carried out in the Sheffield laboratory itself includes a number of intensive studies on the chemical engineering aspects of mixing metals and slags. Experiments have been done on the rate of reaction between metal and slags using various methods of stirring. Some of the more spectacular of these involve breaking down the molten iron into very small droplets (1 mm. diameter and less), and allowing them to fall into the molten slag. In all such experiments the iron-slag mixtures were water-quenched within a minute or so after the additions of iron, and by carefully crushing the slags it was possible to extract the iron droplets, grade them into various size fractions and determine their sulphur contents. The results showed that it was possible to effect a high degree of desulphurization (80 per cent or more) in seconds of time provided a sufficient degree of slag/metal mixing could be achieved. However, the experience obtained suggested that atomization methods would be impractical on a large scale.

The Steelmaking Division has at the laboratories a 10-cwt. electric arc furnace of a design to facilitate experimental work. This is being used for, among other things, studies of the economics of this method of steelmaking with the view of possible extension of its field of usefulness. Many types of high-quality bulk steel which it would be technically advantageous to make in electric arc furnaces are only just beyond the economic borderline, and comparatively small improvements in electric furnace practice might bring them over. In particular, power and electrode consumption are being studied both on production furnaces and on the experimental furnace. The experimental furnace has a very large transformer for its size (500 kV. amp.), and the effects of high power inputs are being examined. The biggest effect so far found is, naturally, that of rate of power input during melting down on power consumed during this period, and in the Association's furnace about 20 per cent less power is required with an input-rate of 500 kV. amp. than with 250 kV. amp.

A further important purpose of the furnace is to provide molten steel for a variety of experiments, mainly on problems of casting. A commercial-scale continuous casting plant to the Association's design is now being built at a Sheffield works, and work continues on the many practical problems involved.

Mechanical Working Division

The Mechanical Working Division has a wide range of metal-forming and experimental plant housed in a fine, one-story building of 10,000 sq. ft. floor area. A 14-ft. four-high reversible cold-rolling mill is equipped to allow as wide a field of cold-rolling research as possible to be undertaken. Operating conditions have therefore been extended far beyond the normal production limits. At present the mill is equipped with a method of automatic gauge control developed by the Association on the basis of some years of work on the causes of gauge variation in rolled strip, in the course of which useful fundamental contributions to knowledge of the plastic behaviour

Metallurgy Division

of metals have been made. Continuous measurement by roll force meters of the separating force of the rolls indicates gauge variation; this is fed into a control circuit which immediately corrects variation either by altering the strip tension or the gap between the rolls. As an example of the potentialities of the method, a rundown of gauge of nearly 0.002 in. on 0.049 in. between 30 ft./min. and 250 ft./min. regularly occurred on an experimental 10-in. two-high mill without automatic control; with it, the entire strip was held to within ± 0.0001 in. at all speeds. The demonstration was repeated on a much larger scale by equipping a 56-in. wide four-stand cold reduction mill, one of the largest of such plants in Europe, with a similar type of control. It was found possible, even on this scale, to roll consistently at all speeds to far closer tolerances than are at present possible without automatic control.

After these trials and demonstrations, a period of intensive development is necessary, in which the Association's 14-in. experimental mill will play an important part. The best methods for development have yet to be decided, and there are other rolling variables, such as thermal expansion and bearing clearance, which may need to be considered and which threaten to increase the complexity of the equipment needed.

Other experimental metal-working plant includes a 200-ton capacity hydraulic forging press and a high-speed two-hole wire-drawing machine with a maximum finishing speed of 5,000 ft. per min. The press is being used to study the effect of forging strain on mechanical properties. Different tool-ratios and reduction-rates are being used, and attempts are being made to correlate the resulting mechanical properties within the material with the actual forging strains as determined from geometrically similar experiments using 'Plasticine'. It may then be possible to specify with more certainty the optimum forging reduction and the sequence of operations necessary to produce desired properties.

The wire-drawing machine is being used for examining problems of high-speed wire-drawing, in particular the limitations imposed by lubrication. The film thickness of the lubricant is being studied by measuring the electric resistance of the die-wire interface. This resistance is much larger than one would expect if the film were only a few molecules thick. Moreover, it is markedly dependent on speed. In one instance, the resistance increased from about 10 ohms per sq. cm. at 5 ft. per min. to about 50 ohms per sq. cm. at 50 ft. per min. with peaks exceeding 500 ohms per sq. cm. Experiments at speeds prevalent in industry are in progress and give a similar picture. Current investigations are also concerned with improved methods of applying the lubricant; for example, by electrodeposition from solution on to the moving wire. It is hoped to obtain in this manner a more consistent thickness of lubricant film and therefore a more uniform performance of the die.

The success of experimental research in metal-working depends to a large extent on the development of theory both to guide the choice of experiments and also to enable the results to be effectively interpreted. There is within the Mechanical Working Division a section concerned with theoretical plasticity, which has made useful contributions to the practical work. Exact and approximate plastic-rigid solutions have been shown by experiment to be a good guide to the behaviour of real metals.

The Metallurgy Division at Sheffield includes facilities for heat-treatment, general metallurgical examination, mechanical, magnetic and electrical testing and X-ray structural studies as well as for chemical, spectrographic and vacuum fusion analysis. The fatigue-testing laboratory and the high-frequency electric furnace, in which 56 lb. of metal may be melted and cast *in vacuo*, are of particular interest.

An important part of the work is concerned with researches on pure materials. Small variations in the amounts of residual elements found between different casts of a steel having a given nominal composition can have a large effect on its properties. Research concerned with the effects of composition on the properties of steels carried out on alloys made from pure materials provides valuable background information. As such research is expensive and cannot be undertaken by every industrial laboratory, it is particularly suitable for a research association. At present this work includes the study of the effects of nitrogen and carbon on the strain-ageing characteristics of pure iron, and the effect of impurities on the magnetic and electrical properties of pure silicon-iron sheet, while a study of the properties of alloys made from pure materials, and having compositions similar to the nominal compositions of commercial steels, is contemplated.

In the studies of silicon-iron sheet of the type used for transformer cores, the effect of small controlled amounts of nitrogen are being studied with the view of determining the indirect effect which nitrogen has through its influence on the crystallographic texture of the cold-rolled sheet, and the direct effect of nitrogen as an impurity. The variations in texture are being studied with a torque magnetometer which gives an indication of the anisotropy, and also by orthodox X-ray methods which give quantitative information about the texture. The magnetic properties of the silicon-iron are being studied by means of a standard instrument.

The fatigue laboratory is equipped with twelve fatigue-testing machines of the two-point loading rotating bending type, similar in design to those used by the Mechanical Engineering Research Organization and the National Physical Laboratory. The speed of the machines is controlled, and rates up to 5,000 r.p.m. are possible, at which speed the machines are clear of any resonance which might influence the results. Each of the twelve machines is therefore able to provide approximately 7,000,000 stress cycles every 24 hr.

The main programme is concerned with the systematic sampling of three commercial casts of steel, using some 3,000 test pieces, to gain information on likely variations within casts of steel and between different casts of steel of the same specification. Information is also sought on whether structural variations in the ingot give rise in the rolled or forged products to significant variations in fatigue properties, and if they do, whether these variations are more pronounced in some ingots of a cast of steel rather than in others. The programme takes into account the fact that it is now widely appreciated that such values as fatigue life, fatigue or endurance limit are not exact values but are, in fact, statistical in nature. It has therefore been planned in collaboration with the Association's operational research section.

BIOLOGICAL SPECIFICATION AND BIOLOGICAL STANDARDS IN THE BRITISH PHARMACOPOEIA, 1953*

By PROF. A. A. MILES, C.B.E.

Lister Institute, London, S.W.1

A NUMBER of reputable drugs in common use to-day have been fully explored by chemists and physicians, so that we know their chemical constitution, and, in many cases, can synthesize them. In a publication like the "British Pharmacopoeia, 1953", which specifies these drugs for public use, it is enough for most drugs to state the degrees of chemical purity required to ensure that the medical practitioner and the general public have medicines upon which they can rely. But there are a number of substances available for the prevention and cure of disease, usually obtained from animals or plants, which we recognize mainly by their biological activity, and although we know something of their chemistry we do not know enough to recognize an active preparation by chemical tests alone.

Some of these 'biologicals' may in time yield to chemical analysis, if they are small enough or simple enough in structure. It is significant that, of the substances in the "Pharmacopoeia" the molecular weight of which can be stated, only sixteen are greater than 500, and two greater than 1,000. We shall wait long for the chemistry of any active principle, not a polymer, that has a molecular weight much greater than 1,000. In the meantime, drugs like insulin and the antitoxic globulins with molecular weights in the tens and hundreds of thousands, and the various immunizing antigens and vaccines, are quite beyond chemical specification. Apart from tests of identity, the most important biological specifications that complete the inadequate chemical and physical specifications in the pharmacopoeial monographs are the potency requirements. Now biological potency is by definition a measure of activity in some biological systems. The system may be a whole animal, such as a cat; part of an animal, like a guinea pig uterus or a suspension of red blood cells; or a culture of bacteria. Whatever the system, our first idea of potency is the amount of a substance that does something observable to it. Since we cannot test the activity in the human subject, we have in all cases to make the assumption that the effect we measure in the biological system is an indication of the effect we want to produce in the human patient. Sometimes that assumption proves to be unjustified, because we are using the wrong biological system, or observing the wrong effect in the right system; but in most cases it has proved to be correct. Our next problem is to translate the effect we observe in the test system into a measure of the potency of the drug.

The estimation of potency as the amount of a substance that produces a defined response in a given biological system is subject to the notoriously high variability of such systems, including the day-to-day variability in one laboratory and variability between laboratories. The limits of error of such 'direct' estimates of potency can only be guessed, and the reliability of such guesses parallels our success in achieving a precise specification of the biological

test system—in most cases an impossibility. When we can make only very imprecise measures of potency, clearly we are in no position to specify a drug that is poisonous in an over-dose or endangers the success of the treatment in under-doses. Happily, in a number of substances the biological activity of which can be measured only by the direct method, over-dosage is not medically dangerous, and we can ensure that the patient gets enough by giving plenty. This state of affairs applies, for example, to the prophylactics used for the prevention of diphtheria. With a substance like insulin, where an over-dose may mean one kind of coma and an under-dose another kind, our methods must be precise. To substances like this it is possible to apply the more precise, 'orthodox' bioassay, in which the biological test system is in effect specified for each assay by testing a standard preparation of the drug in parallel with the unknown. Potency is then expressed in terms of the standard, not, as in the direct assay, in terms of an unstandardizable animal or other biological object. Biological standards may be used in this way when the active material can be preserved in a stable form, and when it is reasonable to assume that the active principle in the standard is homogeneous and similar to that in the material being assayed; and that the biological response observed is due to the substance the therapeutic action of which it is intended to exploit. In the "British Pharmacopoeia" the biological standards prescribed for use are either international standards maintained by the World Health Organization or, when there is no international standard, British standards established by the Medical Research Council.

Bioassay of a drug is sometimes called 'standardization'. The term, however, should be confined to the establishment of the standard preparation. Thus, diphtheria antitoxin was standardized once and for all when, in 1922, the International Standard for Diphtheria Antitoxin was set up and units of potency accepted. Assays of potency made in terms of this standard are parts of the 'specification' of therapeutic and other preparations of diphtheria antitoxin. We thus have a number of drugs the total specification of which, as in a pharmacopoeial monograph, include a biological specification in terms of a standard and, where no standard is available, some much less precise biological specifications in terms of a biological test object.

The bioassays in the "British Pharmacopoeia, 1953" are introduced by a section on the principles of modern bioassay. Most assays are now designed to yield answers such that the responses to graded doses of the standard and the test preparation can be transformed by suitable arithmetical manipulations into numerical values that will yield a linear response when plotted against the logarithm of the dose; and when both the standard and test preparation give substantially parallel linear dose-responses, the potency ratio is readily derived from the logarithmic distance between the two lines. Since the 1948 "Pharmacopoeia", assay methods and biological standards have been made available for aureomycin, scarlet fever antitoxin, globin zinc insulin, *d*-tubocurarine and dimercaprol.

Globin zinc insulin is interesting because, although it is used clinically as a 'delay' insulin, it is not possible to demonstrate any appreciable delay effect in rabbits without using prohibitive numbers of animals. Consequently, there is no test for delayed action in the "Pharmacopoeia".

* Substance of a paper before the Pharmaceutical Society, read on December 10, 1953.

The specification of immunological products leaves much to be desired from the formal point of view. In few of the antitoxins for which there are standards is an orthodox assay, with calculation of fiducial limits of error, prescribed; but the precision and accuracy that might be attained if better assays were defined are probably unnecessary. For a large group of substances—the living vaccinia virus which constitutes the smallpox vaccine, and the living suspension of B.C.G. (*Bacillus* of Calmette and Guérin) which is a tuberculosis vaccine—there are no biological standards; they are all assayed directly in laboratory animals, with the consequent risk of a highly variable result. With B.C.G. vaccine, the results of even the various direct assay and tests have only a retrospective interest, because they take three weeks to six months to complete and the vaccine keeps its potency only fourteen days after issue for use in man. The 'dead' vaccines—that is, bacterial suspensions of killed typhoid and paratyphoid bacilli, whooping cough bacilli, plague bacilli and so forth—are not assayed for potency at all. At present, reliance is placed on the selection of the right strain of microbe to start with, and its proper cultivation and treatment in the manufacture of the vaccine. In other words, the specification stresses the 'pedigree' of the finished product as well as its properties at the date of issue.

With the exception of thrombin, haemoglobin and fibrinogen, none of the human blood products in the "Pharmacopoeia" can be assayed biologically, or even specified in any precise way; but there are precautions to be taken in selecting the donor, whose blood will be the source of the various blood products—"Whole Blood", "Human Serum" or "Fibrinogen", and so forth—all of which are, on the face of it, very sketchily described.

These gaps in the specifications are, however, only apparent. It must be emphasized that all such pharmacopoeial substances—immunological and human blood products—for which the biological specification is superficially inadequate are under the control of the Therapeutic Substances Act. That is to say, they can be manufactured for sale only under licence from the Ministry of Health; it is consequently not enough that a vaccine should be prepared in such a way that it passes a biological test as laid down in the "Pharmacopoeia". Its control ends, not begins, with the test of the finished product. It has always been the policy of the Ministry of Health in applying the Therapeutic Substances Regulations, and of the Medical Research Council in advising on the research aspects of their application, to recognize that the control of these biological substances begins in the producing laboratory, so that all stages from the raw material to the finished product are in charge of expert staff who work so as to leave no loophole for variability so gross as to lead to unwanted results in the use of the drug.

The prescribed methods of control in the "Pharmacopoeia" are instructive in that they range from the simplest tests of activity in the animal to the most elaborate assays which in design and execution would satisfy the most meticulous biometrician. The differences necessarily reflect the differences in our current knowledge of these substances and how to handle them in the laboratory. Imperfection there must be, because we can often recognize and purify an active principle which it would be wrong to withhold from the practitioner of medicine until we

know exactly what it is. But it is comforting to reflect that no such substance is included in the "Pharmacopoeia" unless the imperfections in our knowledge have been removed at least so far as knowing the potentialities of the drug, both beneficial and dangerous. The biological specifications in the "Pharmacopoeia" ensure that we know well enough what amount of a drug will have no effect; what amount will have a beneficial effect; and when the second amount is exceeded, where the danger zone begins.

ALGAL PHYSIOLOGY AND BIOCHEMISTRY

IT has long been recognized that certain algae are particularly suitable as experimental material in the investigation of some of the classical problems of plant physiology and biochemistry. Valuable and extensive information about them has been accumulated, but it seems that concentration upon such species has resulted in inadequate appreciation of the variety of physiological behaviour and chemical activity which is to be found among the algae. A symposium on the physiology and biochemistry of this group of plants, in which the contributions were mainly concerned with species more familiar to marine and freshwater biologists than to most plant physiologists, is therefore of particular interest and an indication of increasing realization of the intrinsic interest of algae. Such a symposium, arranged by the British Phycological Society, was held under the chairmanship of Prof. W. H. Pearsall in the Botany Department of University College, London, on January 1.

In a paper on the physiology of algae other than *Chlorella*, Dr. G. E. Fogg directed attention to features in which certain species being investigated by the Unit for Algal Physiology at University College differ markedly from *Chlorella*, the genus of algae best known to the physiologist. *Monodus subterraneus*, a member of the Xanthophyceae, is morphologically the analogue of *Chlorella*, but unlike members of this genus cannot tolerate wide variation in the composition of the mineral medium in which it grows and appears to be an obligate phototroph. *Anabaena cylindrica*, a nitrogen-fixing blue-green alga, has proved particularly suitable for investigation of the metabolic role of molybdenum. Results recently obtained show that this trace element is not specifically concerned in nitrogen metabolism but that it exerts its effects via carbohydrate metabolism and that the symptoms of its deficiency can be annulled in *Anabaena* if a suitable intermediate such as fumarate is supplied. Although all algae so far examined from this point of view, including *Chlorella* sp., produce extracellular peptides to a greater or lesser extent, *Anabaena* is a particularly favourable organism for the study of this phenomenon. Formation of chemical complexes with toxic or nutrient substances by the extracellular polypeptide of this alga can in certain circumstances have important effects on growth of the organism. The variation in proportions of carbohydrate, fat and protein shown by *Chlorella* spp. according to the conditions under which they are grown is also to be found in other algae, although in *Tribonema aequale*, for example, the possible range appears to be more

restricted. Blue-green algae seem to be incapable of accumulating high proportions of fat, as do *Chlorella* spp., under conditions of nitrogen-deficiency. *Botryococcus braunii*, which possesses chlorophyll *b* and which must therefore be assigned to the Chlorophyceae, is remarkable in accumulating high proportions of unsaponifiable lipid.

Dr. L. Fowden (University College, London), in reviewing present knowledge of the amino-acids and proteins of algae, pointed out that although the early work on this subject represents a considerable technical achievement, analyses by modern methods such as paper chromatography are not only performed more rapidly but also afford much more reliable results. Study of free amino-acids has shown that in *Chlorella vulgaris*, at least, the pattern of their metabolism is similar to that in higher plants. Among the free amino-acids, glutamic and aspartic acids and alanine are present in highest concentration, and other amino-acids can be formed by transamination from these to appropriate keto-acids. There are particular amino-acids characteristic of certain groups; this affords another example of the correlation to be found between biochemistry and classification in the algae. Quantitative analyses of the amino-acids of the bulk proteins of several algae, including *Chlorella*, *Tribonema*, *Navicula* and *Anabaena*, have now been made and show that the same amino-acids are present in much the same proportions as in the green leaves of higher plants. Early reports that certain amino-acids are absent from the proteins of some groups of algae were based on results obtained with inadequate analytical techniques. The proportions of different amino-acids in the bulk proteins of *Chlorella vulgaris* do not change markedly during the growth of cultures. Nothing is known as yet of the individual proteins of algae; but study of them is beginning with attempts at their separation by electrophoretic methods.

A paper by M. R. Droop (Marine Station, Millport) was concerned with the biology of hamatochrome in *Haematococcus pluvialis*. The accumulation of this pigment, the principal constituent of which is the carotenoid astaxanthin, is known to be promoted by high light intensity, by the supply of acetate, or by nitrogen deficiency. These effects have been confirmed; but it has been found that hamatochrome is also formed when growth is limited by phosphate, nitrate being in excess. No hamatochrome appears while cell multiplication is going on; when growth has ceased, its accumulation is most rapid when both organic carbon and carbon dioxide are available and slowest when carbon is in short supply. The effect of organic carbon is independent of light. It seems, therefore, that the formation of hamatochrome is promoted by factors which inhibit cell division but not carbon assimilation. Superficially, hamatochrome appears to be a reserve product, but its utilization and its relations to starch and fat have not been investigated. The red *Haematococcus* which occurs naturally is in a non-dividing condition, the dense populations which are often met with appearing to be built up rapidly from large numbers of aplanospores.

The kinetics of growth of a marine unicellular alga, long known as *Nitzschia closterium* forma *minutissima* but of doubtful affinities, were described by Dr. O. P. Spencer (Marine Station, Bangor). This form, unlike most marine algae, is sufficiently robust for routine laboratory handling and has the further advantage that its growth may, under certain con-

ditions, be followed accurately by determination of the optical density of the culture. The alga undergoes a period of exponential growth following inoculation into fresh medium, but even under constant conditions irregularities sometimes occur in this phase. These irregularities disappear on repeated subculture in medium of the same composition, and appear to be connected with adaptation to altered phosphate concentration. A lag phase is observed following inoculation into fresh medium if the inoculum is taken from a culture in which maximum cell density has been reached. Unless a massive inoculum is used, a lag phase of about five hours is also observed if the parent culture was in the early exponential phase. This suggests that some factor excreted by the cells must reach a certain concentration in the medium before exponential growth can begin, and this idea is confirmed by the finding that there is no lag following inoculation from the early exponential phase into medium in which growth has already occurred and which has been enriched with phosphate and nitrate. These results were obtained with media in which nitrate was limiting; phosphate-deficient media may produce cells having a lag phase of the order of ninety hours. Relatively high concentrations of phosphate sometimes exert a lethal effect, a phenomenon that has been observed with certain other algae and which may make it advisable to use phosphate-poor media when bringing a species into culture for the first time.

The mechanism of the absorption of glucose by *Scenedesmus quadricauda* was considered in a paper by F. J. Taylor (Queen Mary College, London). In oxidative assimilation by this organism, one-sixth of the glucose taken up is oxidized, the remainder being synthesized to polysaccharide. The increase in oxygen uptake following addition of glucose is immediate, and the uptake of glucose remains linear with time. This last fact and the observation that oxygen is essential for glucose uptake suggest that the process is one of active absorption rather than one of simple diffusion. Various observations are consistent with the idea that this active absorption is effected by a phosphorylase situated on the cell surface. Thus, no free glucose has been detected inside the cells by chromatographic methods, and phloridzin, which is apparently a specific inhibitor for phosphorylases, inhibits glucose uptake without reducing the rate of endogenous respiration. The rate of uptake of glucose remains constant as its concentration is increased until, corresponding with plasmolysis, there is an abrupt rise. This may perhaps be due to the uncovering of further enzymatic groups in the plasma membrane as it parts from the cell wall. No marked effect of age of culture on rate of glucose uptake was observed. Light has been found to stimulate the process.

Demonstrations illustrated some of the techniques in use in University College, London, for the study of algae. These included culture apparatus for various purposes, the most elaborate being an apparatus for continuous culture of unicellular algae, in which constant conditions and cell density are maintained by electronic control. Numerous species of unicellular and filamentous algae, both freshwater and marine, were exhibited in small-scale culture together with large-scale cultures (36- and 10-litre respectively) of *Chlorella* and *Tribonema*. The preparation of cell-free homogenates of algae for protein analysis was demonstrated, and various cytological preparations of blue-green algae were also exhibited.

NEW ZEALAND DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANNUAL REPORT FOR 1952-53

THE twenty-seventh annual report* of the Department of Scientific and Industrial Research, New Zealand, covers the year ended March 31, 1953. It includes the Minister's statement, the Secretary's report and reports from the several branches of the Department, as well as from the Cawthron Institute, the Commonwealth Agricultural Bureaux, the research associations, the Manufacturers' Research Committee and the university colleges to which grants were made by the Department. The Minister's statement, stressing the way in which, particularly in the primary industries, the Department is assisting to put the results of scientific effort into practical use more rapidly than ever, and the satisfactory extent to which the Department has succeeded in establishing effective collaboration with other bodies in dealing with economic scientific problems, suggests that it is now an appropriate time to review the basis upon which research associations are financed by industry and by the State.

The Secretary's report notes a reduction in staff during the year from 1,012 to 931, that in professional staff being from 402 to 374. There were also considerable reductions in capital charges, in purchases of equipment and supplies and in travelling expenses, but reductions were spread as widely as possible. A critical analysis of the Department's expenditure of £1,020,720 estimates that 26 per cent was on long-term applied research; 22 per cent on scientific services for other government departments; 17 per cent on research and services to primary industry; 10 per cent each for defence science and on administration, information service, etc.; 7 per cent on research and services to manufacturing industry; 5 per cent on research grants; and 3 per cent on grants to British Commonwealth and international scientific institutions. It is estimated that the expenditure on research, as distinct from services, is probably about 43 per cent, and, reviewing the results of this expenditure over the past twenty-seven years, the Secretary points out that grassland research has enabled New Zealand, by breeding new strains of pasture plants and studying their management and utilization, to attain front rank as a pasture country with an exceptionally high yield of meat, butterfat and wool per acre. The annual production of fodder has been largely increased, the season of grass growth being extended by at least two months. New methods have been used for combating such serious diseases as facial eczema and bloat, and a considerable export trade has been built up in pedigree grass and clover seeds.

Soil surveys of the whole of New Zealand have been completed, and on this basis areas of erosion, of deficiency in lime and phosphate, and of the occurrence of plant and animal deficiency diseases have been mapped and the foundation thus laid for the utilization of the Dominion's soil resources. The areas liable to bush sickness have been defined and are now being brought into successful production. Research into plant diseases has brought many of them under complete control and others have been

made amenable to spray treatment. The fruit-growing industry has been provided with sound methods for the control of fungal and bacterial diseases and of insect pests, and bunt and smut diseases of barley and wheat are now rare. Research in fruit transport has eliminated the serious losses which were common twenty-five years ago in shipments to the United Kingdom. The serious physiological disease of apples, known as corky core, has been traced to boron deficiency and is easily and cheaply remedied. The wheat industry has been provided with a series of varieties unsurpassed in yield and quality of flour and in marked contrast to the Tuscan variety which they have replaced. The two most serious insect pests of pastures, grass grub and grass caterpillars, have been brought under control economically, as well as the diamond back moth which in bad seasons inflicted losses of turnips, rape and cabbage estimated at tens of thousands of pounds; and methods have been found by which South African citrus fruit may be imported to New Zealand without risk of introducing serious insect pests.

Recent research has discovered the cause of the yellow-leaf disease threatening the phormium industry and has indicated remedial measures which have removed the worst threat. Research in the tobacco industry since 1920 has led to the area under this crop being doubled as well as the yield of leaf per acre. The linen-flax industry has been established on research carried out by the Agronomy Division at Lincoln, the fish-liver oil industry on the investigations of the Fats Research Laboratory into the vitamin content of New Zealand fish livers, and the agar industry on the seaweed researches of the Botany Division and the Dominion Laboratory. These and other advances due to the research activities of the Department have afforded savings in any one year that would repay the whole of the State expenditure of nearly £8 millions on the Department during the past twenty-seven years.

The Secretary points out that so far no agreement has been reached regarding an adequate organization for the scientific problems of the building industry: in the Department's view, such an organization should be capable of adapting advances in building research institutions overseas to the special conditions of New Zealand; of undertaking research into New Zealand building problems and of disseminating knowledge to the industry. Progressive improvement in accommodation in many branches of the Department is recorded, including new premises for a section of the Geological Survey and for the Geophysics Division. The removal in the near future of the Botany Division headquarters to Christchurch should relieve the serious overcrowding in this Division of many years past.

Outstanding economic achievements of the year include savings estimated at £30,000 to Auckland tomato growers through the elimination of *Botrytis* disease by incorporation of a special fungicide in the hormone sprays used to induce setting of the fruit from early flower trusses. Investigations with the use of hormone sprays have now indicated that some 70 per cent of the cost of thinning apples in Hawke's Bay orchards can be avoided, with savings estimated at £20,000 annually, while in the fruit-growing districts of Central Otago treatment of pears, peaches and nectarines with zinc salts has checked die-back and restored normal vigour. Investigations on frost injury to fruit trees by facilitating more reliable pre-

* New Zealand. Twenty-seventh Annual Report of the Department of Scientific and Industrial Research. Pp. 108. (Wellington: Government Printer, 1953.)

diction of dangerous frosts has offered operating economies in fuel and labour. The Crop Research Division has produced strains of Blue Prussian and Greenfeast peas of proved resistance to wilt diseases, thus permitting higher yields and the more frequent use of peas in cropping rotation.

Tests in ground infested with black root-rot disease indicate that two varieties of tobacco introduced from the United States give yields higher by more than 500 lb. of leaf per acre, thus enabling tobacco to be grown profitably on areas abandoned on account of infestation by root-rot. Inoculation of the soil with methyl bromide has been shown to be as effective as steam sterilization for control of weeds in tobacco seedling beds, and the application of maleic hydrazide when the tops are removed eliminates all subsequent labour in the removal of lateral shoots. A considerable measure of control of stone fruit blast has been obtained by the Plant Diseases Division with the antibiotic streptomycin; nodule bacterial work in the same Division has produced a strain that promotes rapid establishment of clover in the raw pumice soils of the Wairakei-Tampo area, and complete control of thrips on onions has been obtained with DDT spray applied as an emulsion. The headnut disease and cutworm pests, which have been making serious inroads on the yields of maize in Poverty Bay, have been brought under control by means of a heavy dressing of fungicide in which an insecticide that deals with the cutworms is incorporated.

By a simple modification of the diffusion process of treating timber with boric acid, in which the green sawn timber is passed through a bath or spray of concentrated boric acid/borax solution and then held in block-stacks for a specified period, an inexpensive method of treatment has been evolved which was being tested on a semi-commercial scale. Promising results in breeding a new improved type of perennial ryegrass have been obtained in first-generation hybrids from perennial and short-rotation ryegrass, and the establishment of a well-balanced pasture-sward during the initially difficult stages has been facilitated by halving the amount of grass seed in an ordinary pasture mixture. At the Te Awa hill station the carrying capacity of pastures was increased to four ewes per acre compared with one wether a few years ago. Investigations on the control of grass grub and perina, which cause losses estimated at £6 millions annually, are continuing; but meanwhile the Entomological Research Station's recommendations for a DDT treatment costing less than £1 an acre has been substantiated.

Detailed soil surveys of the Gisborne Plains, Foxton Sands, Canterbury Plains and Downlands and the Heathcote Valley horticultural areas, and detailed geological and geophysical surveys of the Wairakei and Te Teko geothermal areas were completed during the year. Surveys were being extended northwards to the Waitapu area, and the use of the steam resources now being tapped was under consideration for the production of heavy water. The Department was also associated with the scientific aspects of the completely successful shipment of chilled beef, the first since pre-war years, by the New Zealand Meat Producers' Board to London on the *Dominion Monarch*. Various sections of the Department gave valuable assistance to several aspects of the work on the Maraetai hydroelectric dam, including stress and vibration measurements, and advice on paints and their protection; a special

feature was the examination by the gamma-ray equipment of the Dominion Physical Laboratory of all welds within the metal of the penstock controls and the location of flaws. In consequence, repairs to the penstock equipment were made in New Zealand, and the dam was brought into operation several months earlier than scheduled. The five industrial research associations of the Department all had successful years, and the Manufacturers' Research Committee gave special attention to the organization of trade research groups within the Auckland Industrial Development Laboratories and the Canterbury College Industrial Development Department so as to provide scientific assistance to manufacturing industries too small to form research associations.

ROYAL OBSERVATORY, CAPE OF GOOD HOPE

REPORT FOR 1952

THE report of the Royal Observatory, Cape of Good Hope*, for 1952, which has recently become available, shows that it was "a reasonably satisfactory" year for the Observatory. The weather, from the point of view of observing, was well above average during the first part of the winter, and good progress was made with the observing programme both at the Cape and at Pretoria. It was very satisfactory that the H-region zero-point programme was completed in a year, thus providing the material for rounding off the first half of the standard magnitude programme on which the Observatory has been engaged for a long time.

As stated in the report for 1951, arrangements were made for an examination of the declination axis of the Victoria telescope, in consequence of which it was out of action during a great part of 1952. Temporary repairs were not satisfactory, the motion of the telescope being still very stiff, and it was decided to fit modern roller and thrust bearings. This was not completed before January 1953; but it was possible to use the instrument for short periods between the various stages. The motion of the telescope is now quite smooth and easy, but it was used on only 63 nights during the whole year as compared with 177 nights in 1951. The opportunity was taken during the periods when the instrument was out of action to remove from the pier the old and massive weight-driven clock which was superseded in 1850 by a comparatively small electric synchronous motor, and at the same time to renew much of the electric wiring and to fit a new slow-motion motor. The tube of the 24-in. telescope was shortened by three inches in preparation for the fitting of the new lens cell recently made by the firm of Cox, Hargreaves and Thomson.

The astrographic refractor was used on 178 nights—32 more than during the previous year—in spite of the fact that it was out of commission for about three weeks in October and November in connexion with the remounting of the photometric cameras. Since their return from Cambridge, they have been adapted to use standard 16 cm. x 16 cm. plate-holders and have been fitted with new exposing-shutters working in front of the lenses and with an extra long dew-cap fitted with internal diaphragms to keep out

* Report of Her Majesty's Astronomer at the Cape of Good Hope to the Secretary of the Admiralty for the year 1952. Pp. 16. (Cape of Good Hope: Royal Observatory, 1952.)

scattered sky light. Although the instrument behaves fairly well, its drive and clamping mechanism need a thorough overhaul; the dome does not turn very freely, and the axles and bearings of the wheels carrying it are badly worn and will soon require renewing. The 7-in. telescope, now that the "Bright Star Programme" is finished, is used for observing occultations, and also by Mr. W. P. Hirst, a local amateur, for the micrometric measurement of double stars; Mr. A. G. F. Morrisby also uses it for observing variable stars. The 6-in. telescope, still utilized by visitors and for observing occultations, has been used regularly by Mr. R. P. de Kock for observing long-period variable stars. The Tower telescope and the photoheliograph, as described in the 1951 report, continue to be used, the first for observing occultations and variable stars, and the second for taking photographs—two each day—of the sun. A new photoelectric photometer, which was built during 1952 and used for a time on the Victoria telescope, has been transferred to the astrographic telescope to replace the old and rather inefficient photometer that was built originally for the 7-in. telescope; this new photometer will be used for the "Bright Star Programme" already referred to.

Nearly half the report is included under the heading "Observations and Reductions", and comprises: meridian observations, photographic star positions and proper motions, the parallax programme, Radcliffe section, stellar photometry, photoheliograph, occultations and variable stars. Under each of these, full accounts are given of the progress during the year under consideration. In the section on stellar photometry, reference is made to the photometric cameras, which were not mounted on the astrographic refractor until November 1952, and were brought into use in December. An outline of the two short programmes for this instrument is given, the second of which is required to complete the work done at the University of Cambridge Observatories.

A reorganization of the time service and clock installation was begun in August; but much detailed work still remains to be done, although the major changes were completed by the end of 1952. All the telephone cables in the grounds have been completely renewed by the G.P.O., to whose "remarkable speed, efficiency and close cooperation throughout, the Observatory is deeply indebted", in the words of the director. The Observatory keeps a limited stock of chronometers and watches for issue to H.M. ships; in 1952 nine were issued and ten received. Meteorological work proceeded on the usual lines, continuous records being obtained of barometric pressure, temperature, humidity, wind direction and wind velocity on self-registering instruments.

Towards the end of the report reference is made to the jubilee meeting of the South African Association for the Advancement of Science, which was held in July and which brought a number of distinguished scientists to Cape Town. After the meeting, Prof. J. H. Oort gave a popular lecture under the auspices of the Board of Extra-Mural Studies of the University of Cape Town, and so great was the popular response to this lecture that, by request of the University, Dr. D. S. Evans gave a series of six evening lectures on modern astronomical problems, which were all very well attended. Earlier in the year an astronomical exhibit, organized by Dr. Evans, was shown in the Hall of Science at the van Riebeeck Festival Fair.

It is satisfactory to know that, in addition to the regular visiting days and the opening of the Observatory for inspection one afternoon a month, the 5-in. and 6-in. telescopes have been placed at the disposal of the Cape Centre of the Astronomical Society of South Africa for the entertainment of visitors. These evenings have proved so popular that there has always been a long waiting list for the admission permits.

EUROPEAN TIMBER TRENDS AND STATISTICS

IN two United Nations publications, "European Timber Trends and Prospects"* and "European Timber Statistics, 1913-1950"†, the Food and Agriculture Organization of the United Nations has summarized information collected jointly by it and the Timber Committee of the Economic Commission of Europe; the second publication arises more or less out of the investigations contained in the first.

In the autumn of 1947, when the Timber Committee of the Economic Commission of Europe was first established, its purpose was to help European governments to overcome, through concerted action, the acute timber shortage which was hampering European reconstruction. To a certain extent success was achieved, despite the temporary disappearance of the U.S.S.R. as a large source of soft-wood supplies and without aggravating Europe's dollar deficit through continuous heavy imports of North American timber. By 1949 the temporary equilibrium reached was precarious and obviously unstable, and war restrictions in the consumption of timber and paper were still in force. But the questions still remained of whether or not Europe was still faced with a timber shortage, and how would supply and demand of forest products develop over a longer span of years. The Committee therefore undertook a study of European timber production, consumption and trade, primarily to find answers to these questions, and its findings are jointly summarized in "European Timber Trends and Prospects", which is a monumental piece of research work. The resulting beliefs appear to be that by 1960 Europe may be deficient in timber unless she increases her own production by a "dynamic forest policy" of reforestation and so forth, or imports larger amounts from North America and the tropical forests. It is open to doubt, taking into consideration the considerable period of time it takes trees to reach timber size, whether long forecasts are possible.

In the accompanying volume on "European Timber Statistics, 1913-1950" the periods covering the war years 1914-19 and 1939-45 have been excluded owing to the lack of adequate statistical information about them. This may seem to lessen the value of the inquiry somewhat since excessive fellings were made in the forests during the two World Wars, fellings which reduced subsequent consumption for a number of years. The volume is divided into three sets of tables, dealing respectively with production, trade

* *European Timber Trends and Prospects: a Study prepared jointly by the Secretariats of the Food and Agriculture Organization of the United Nations and the United Nations Economic Commission for Europe.* Pp. xvi+315. (Geneva: U.N.(F.A.O.); London: H.M.S.O., 1953.) 14 Swiss fr., 25s. or 3.50 dollars.

† *European Timber Statistics, 1913-1950: Statistiques Européennes du Bois, 1913-1950.* Pp. v+168. (Geneva: U.N.(F.A.O.); London: H.M.S.O., 1953.) 7 Swiss fr., 12s. 6d., or 1.75 dollars.

and consumption. It is stated that the object of the investigation is an attempt to fill a need felt by the majority of those entrusted with the role of wood in the European economy or who have tried to grapple with the timber problem on a European scale. For the first time, it is claimed, an attempt has been made to arrive at figures for trade and production in wood and its products for every European country, and to bring them together in the form of a convenient reference. This aim appears to have been usefully achieved. The volume has an increased value as it is in both English and French, the former on the left-hand pages and the latter on the right—a most effective method of increasing its utility.

E. P. STABBING

PARAMAGNETIC RESONANCE IN NEUTRON-IRRADIATED DIAMOND AND SMOKY QUARTZ

By DR. J. H. E. GRIFFITHS, J. OWEN and I. M. WARD

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THE nature of lattice defects in neutron-irradiated diamond is a problem of current interest. These defects are known to cause changes in some of the physical properties¹ and give rise to a paramagnetic absorption spectrum. We have measured this spectrum in the temperature-range 20°–290° K., using wave-lengths of 1.2 and 3.1 cm. There are many closely spaced lines, of which two main types can be distinguished.

(a) There is an isotropic absorption line with spectroscopic splitting factor $g = 2.0028 \pm 0.0005$. Both the intensity and width increase with duration of irradiation, but are reduced after the diamond has been heated to about 1,000° C. (The intensity of the coloration produced by the irradiation varies in a similar way.) The line width, which after long irradiation is of the order of 100 gauss, decreases with temperature, being approximately half as big at 90° K. as at 290° K. This type of absorption line has also been observed in diamonds coloured by electron irradiation.

(b) There is an anisotropic spectrum consisting of lines symmetrically arranged about the type (a) line, and of the order a hundred times smaller in intensity. The intensity does not appear to be affected after heating to 1,000° C., and the line width is independent of temperature, being of the order of 5 gauss. This structure has been investigated in several Type 1 and Type 2 diamonds where the large central line had been reduced by heating. It is found that the positions in the spectrum of the most intense twelve of these anisotropic lines are identical in all the specimens that we have examined. They appear to arise from paramagnetic units in the crystal with electronic spin $S = 1$, the spin-levels being separated into a doublet and a singlet (separation $D = 0.010$ cm.⁻¹) by a crystalline field of nearly axial symmetry. This axis is found to be parallel to one of the six edges of the fundamental carbon tetrahedron of the diamond lattice, so that there are six differently oriented units present, each giving two lines in the spectrum (see Fig. 1). The mean spectroscopic splitting factor is $g = 2.0027 \pm 0.0005$, and has a very small anisotropy given by $g_{\perp}/g_{\parallel} = 1.00035 \pm$

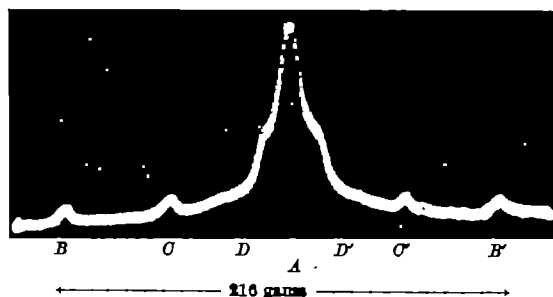


Fig. 1. Spectrum from an irradiated diamond with magnetic field H parallel to $[111]$. A , central type (a) line (reduced by heating); B and B' , lines from one unit with axis parallel to H (that is, parallel to $[111]$); C and C' , lines from one unit with axis perpendicular to H ; D and D' , superimposed lines from four units with axes inclined at 60° to H .

0.00005 . For a general direction of the magnetic field the positions of the lines from each unit are given by the usual spin Hamiltonian $\mathcal{H} = \beta H \cdot g S + DS^2$, the constants having the values given above. Apart from these twelve lines, other smaller lines are also present, the intensities and positions of which in the spectrum are not found to be the same in all specimens.

A preliminary theoretical investigation of the magnetic properties of neutron-irradiated diamond, in which it is assumed that carbon atoms are knocked into interstitial positions leaving vacancies in the lattice, has been made by Pryce². Although it is too early to give any detailed interpretation of the spectrum described above, a tentative explanation which would give the correct spins of $S = 1$ and the particular axes of distortion is that this spectrum arises from interstitial carbon atoms linked together in pairs.

The centres which are produced in quartz by X-irradiation, giving rise to the well-known smoky colour, appear to be of a different kind from those in diamond, and have been thought for some time to be connected with the presence of impurity atoms in the silica lattice (see, for example, Brown and Thomas³). We have investigated the paramagnetic resonance in irradiated natural crystalline quartz and have found that a few hours irradiation by either neutrons, electrons or X-rays gives rise to the same spectrum. Prolonged irradiation by neutrons gives rise to additional absorption lines which will not be discussed here. For quartz irradiated by X-rays, it appears that the intensity of paramagnetic absorption is directly proportional to the coloration produced; the lines are completely removed by heating the quartz to 350° C. The spectrum is also found in synthetic quartz, but is much reduced in intensity.

Measurements using wave-lengths of 1.2 and 3.1 cm. have been made at 90° K., the lines being very much broader at higher temperatures. The results indicate that there are six types of paramagnetic unit, each with electronic spin $S = \frac{1}{2}$ and the same principal g -values ($g_{\parallel} = 2.06 \pm 0.005$; $g_{\perp} = 2.00 \pm 0.005$), but with differently oriented axes of magnetic symmetry. Each of the six absorption lines appears to be subdivided into six lines of roughly equal intensity with an overall separation of about 28 gauss at both wave-lengths (see Fig. 2). It is possible that this is a hyperfine structure, which suggests that the magnetic centres involve electrons,

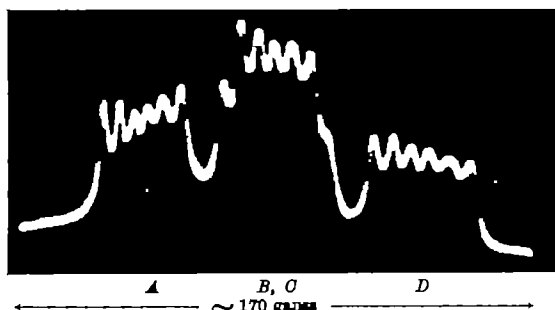


Fig. 2. Part of spectrum at 1.2 cm. from smoky quartz including four of the six blocks of absorption lines. A and D, separate blocks showing the subdivision into six lines. B and C, two blocks with their centres displaced by one 'hyperfine' space.

moving in orbits closely associated with foreign atoms in the lattice, which have nuclear spin $I = 5/2$. The most likely impurity elements satisfying this interpretation are aluminium-27, manganese-55 and iodine-127, and of these aluminium is the most probable.

It is hoped to test this tentative explanation of the spectrum by measuring synthetic quartz into which known impurities have been introduced.

We would like to thank the Diamond Corporation, the Physics Department, University of Reading, the General Electric Company and the Atomic Energy Research Establishment, Harwell, for the loan and irradiation of specimens, and also Dr. A. H. Cooke, who first reported to us the presence of resonance lines in diamonds. [Dec. 18.]

¹ Dugdale, R. A., *Brit. J. App. Phys.*, 4, 334 (1953).

² Pryce, M. H. L., Diamond Conference, Oxford (1953).

³ Brown, C. S., and Thomas, L. A., *Nature*, 169, 53 (1952).

EXPERIMENTAL INDUCTION OF BUDS FROM FERN LEAF PRIMORDIA

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RECENT comparative and experimental studies of leaf morphology have aroused a renewed interest in the relationship between leaves and buds. In the fern *Dryopteris aristata*, Wardlaw^{1,2} has shown that bud and leaf primordia are histologically identical, and that buds may be caused to develop at presumptive leaf positions when these are isolated from the shoot apex by a tangential incision. Similar preliminary experiments^{3,4} on the isolation of young emergent leaf primordia resulted in the development of awl-shaped leaves of limited growth and approximately radial symmetry, with associated axillary buds. Further experiments reported below have shown that under certain conditions it is possible to cause such leaf primordia also to develop as buds. (Following the terminology of Snow and Snow⁵, leaf primordia visible at the time of the operation will be called P_1 , P_2 , etc., P_1 being the youngest; primordia which were initially invisible but which developed during the course of the experiment will be called I_1 , I_2 , etc., I_1 being the first to arise.)

Leaf primordia of *Dryopteris aristata* were isolated from the shoot apex and adjacent primordia by four

fairly deep incisions. The isolated plugs were rectangular in shape and were relatively large; the majority of the plugs were elongated in a direction tangential to the shoot apex (Fig. 1A), but a few were elongated radially (Fig. 1B). These operations were carried out on primordia P_1 - P_4 over a period of ten months, from March to December 1953, and have resulted always in the development either of a bud or of a normal, dorsiventral, circinate leaf primordium. The results of the experiments are presented in Table 1. It was found also that, as in the case of Wardlaw's^{1,2} experiments on the I_1 presumptive position, isolation of the primordium from the shoot apex by a single tangential incision was sufficient to cause its development as a shoot bud. Notwithstanding the marked seasonal metabolic changes known to occur⁶ in the apex of *D. aristata*, neither the season of its collection nor the growth-rate of the apex had any effect on the development of the isolated leaf primordia.

Table 1. DEVELOPMENTAL ANALYSIS OF EXPERIMENTAL ISOLATIONS OF LEAF PRIMORDIA

Primordium isolated	Total No. of viable isolations	No. which developed as buds	No. which developed as leaves	No. which developed as leaves, or moribund leaves, with associated axillary buds
P_1	120	111	9	—
P_2	27	20	6	1
P_3	10	2	7	1
P_4	7	—	5	2

It is clear from these results that the youngest three leaf primordia, at least, are capable of development as buds if they are isolated from the influence of the shoot apex. While Table 1 gives a reliable indication of the ratio of buds to leaves which may be expected from isolations of P_1 , in many cases the examples of P_2 and P_3 were chosen because their relatively flat appearance indicated that they might be capable of development as buds. The results for P_2 and P_3 , therefore, do not give a reliable estimate of the proportion of buds to be expected from random isolations of these primordia.

From Table 2 it is evident that leaf primordia isolated at a late stage of the plastochrone yield a higher proportion of leaves than those isolated at an earlier stage. Careful observation of leaf ontogeny has shown that the distinction can be rendered more precise. A leaf primordium arises from the outgrowth of a group of equal prism-shaped cells of the apical meristem⁴; afterwards one of these cells, near the centre of the locus of growth, enlarges and grows

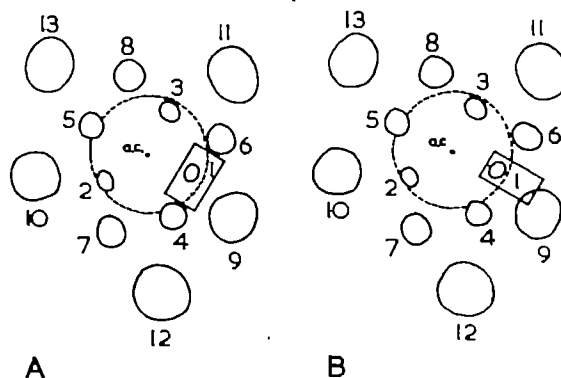


Fig. 1

Table 2. THE EFFECT OF THE STAGE OF THE PLASTOCHLONAL ATTAINED AT THE TIME OF ISOLATION ON THE SUBSEQUENT DEVELOPMENT OF ISOLATED P_1 PRIMORDIA

Stage of plastochlone	Total No. of viable isolations	No. which developed as buds	No. which developed as leaves	Per cent buds	Per cent leaves
Early	87	36	1	97.8	2.7
Middle	53	56	2	96.6	3.4
Late	25	19	6	76.0	24.0

out, taking precedence over the other cells. Ultimately this cell becomes very much enlarged, and its lateral walls become convex; at this stage it is recognizable as the characteristic lenticular apical cell of the leaf of this species. Before a single cell has visibly taken precedence over the other cells of the primordium and has grown out from the surrounding tissue, a primordium is capable of development as a bud, but after a single cell has become dominant and is beginning to become lenticular in shape, the primordium is no longer able to develop as a bud and, under the conditions of these experiments, will develop as a normal, dorsiventral leaf primordium. The stage at which a primordium attains this condition is variable in different apices; this explains how some primordia are still capable of developing as buds at as late a stage as P_2 . This has been confirmed by anatomical investigation. There must therefore be a close temporal relationship in this species between the irreversible physiological changes which impose upon a primordium dorsiventrality and a capacity for rapid but ultimately limited growth, and the formation of its apical cell. Such a relationship renders it possible to predict with a high degree of certainty which leaf primordia are capable of development as shoot buds under the prevailing experimental conditions.

Attempts were made to mark the centre, or, where visible, the apical cell of the primordium at the time of isolation with a free-flowing brand of Indian ink, applied with a small paint brush from which the majority of the bristles had been excised. No toxic effects of the ink were observed. Due to technical difficulties, it was not always found possible accurately to mark the central cell of the leaf primordium, and any initial discrepancy between the mark and the centre of the primordium became magnified as a result of growth and cell division. It was invariably found, however, that the ink mark occupied the same position relative to the apex of the induced bud as initially it had done relative to the apex of the leaf primordium. It therefore seems certain that the apex of the isolated leaf primordium does give rise to the apex of the bud.

The first leaf primordium of the induced buds always arose on the longest axis of the isolated plug, and in cases where the primordium was symmetrically situated on the plug two leaf primordia frequently arose almost contemporaneously, approximately opposite to one another. On plugs of the type illustrated in Fig. 1A, the first leaf primordium arose more frequently on the P_1 side of the plug than on the P_2 side; that is, on the side where there is slightly more space, since the isolated P_1 primordium is situated slightly closer to P_2 than to P_1 . Further experiments are necessary to establish the underlying cause. Normal spiral phyllotaxis usually was not established until after the inception of at least six leaf primordia; this is in agreement with observations on seedling apices of various angiosperms^{1,2}.

The vascular system of the induced buds was solenostelic; that of isolated primordia which developed as leaves was solenostelic at the base with normal leaf vascular structure distally^{3,4}. No vertical contact was ever made with components of the shoot stele; this is probably the reason for the ultimately rather limited growth of both induced buds and isolated leaves.

It appears that the different results obtained in earlier experiments on the isolation of leaf primordia were due to a difference in the position of the cuts, which were made as close to the primordium as possible⁵. Spatial and nutritional effects are still under investigation and have not yet been fully considered. It will be of interest also to determine the exact depth of incision which is necessary to permit development of the primordium as a bud.

From these experiments and those of Wardlaw^{1,2} it is apparent that, in *D. aristata*, leaf primordia are initially capable of development either as leaves or as buds, depending on the conditions operative upon them. This provides evidence against the existence of specific leaf- and bud-forming substances. Under normal conditions the primordia develop as leaves, determinate organs of dorsiventral symmetry and rapid growth, but it is possible to change their destiny by isolating them from some influence of the subtending shoot apex at a sufficiently early stage. Sussex⁶ was able to induce centric leaves in the potato by isolating the I_1 presumptive position from the shoot apex, and leaves of radial symmetry have been observed in the course of other experiments⁷⁻¹¹, always associated with either destruction or attenuation of the shoot apex. From plants of *Oenothera lamarckiana* which had been maintained under unfavourable conditions after destruction of the shoot apex, Lang⁸ obtained leaves bearing lateral and terminal buds, in addition to cylindrical organs, and leaves which gave rise apocarpously to prothalli at their tips. In some cases the tip of the leaf became transformed into a shoot bud. It appears, therefore, that the induction in the primordium of dorsiventral symmetry and of the biochemical conditions characteristic of leaf growth is initially due to factors extrinsic to the primordium itself and is a function of the active shoot apex, but the mechanism by which this is brought about is not yet understood.

The results of these experiments clearly provide some measure of support for the partial-shoot theory of the leaf developed by Arber^{12,13} as a result of comparative studies of angiosperms.

I am indebted to Prof. O. W. Wardlaw for his guidance and encouragement throughout the investigation. This work was carried out during the tenure of a Berry Scholarship awarded by the University of St. Andrews.

¹ Wardlaw, O. W., *Nature*, 164, 167 (1949).

² Wardlaw, O. W., *Growth* (supplement), 9, 93 (1949).

³ Wardlaw, O. W., *Phil. Trans. Roy. Soc., B*, 233, 343 (1947).

⁴ Wardlaw, O. W., *Phil. Trans. Roy. Soc., B*, 233, 415 (1949).

⁵ Snow, M., and Snow, R., *Phil. Trans. Roy. Soc., B*, 231, 1 (1931).

⁶ Fraser, H. L., *Ann. Bot.*, N.S., 10, 391 (1946).

⁷ Van Ierssen, G., "Mathematische und Mikroskopisch-Anatomische Studien über Blattstellung" (Jena, 1907).

⁸ Schemm, I. M., *Nature*, 167, 651 (1951).

⁹ Lang, W. H., *Memo. and Proc. Manchester Lit. and Phil. Soc.*, 55, 53 (1924).

¹⁰ Snow, M., and Snow, R., *Phil. Trans. Roy. Soc., B*, 236, 63 (1935).

¹¹ Wardlaw, O. W., *Ann. Bot.*, N.S., 9, 383 (1945).

¹² Arber, A., *Biol. Rev.*, 16, 81 (1941).

¹³ Arber, A., "The Natural Philosophy of Plant Form" (Camb. Univ. Press, 1950).

LETTERS TO THE EDITORS

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Measurement of Length and Angle in Quantum Mechanics

I WISH to point out that in the accepted theory the association of operators and observations is very intricate precisely in the simplest cases. You give me a splinter of a diamond crystal. Its state function is to be an antisymmetric function of the co-ordinates x_i of the n carbon nuclei the specimen contains. Can this function give information on the *shape* of the splinter? The label k is not connected with any location, with any point of the crystal lattice! Let the splinter be needle-shaped. I can measure its length. What operator is associated with this measurement? We must remember that only operators *symmetric* with respect to all the x_i are meaningful.

The only answer I can find to the last question is this. Let $r_{kl} > 0$ be the distance between the k th and the l th carbon nucleus ($k \neq l$). Let F be a symmetric function of the $n(n-1)/2$ variables r_{kl} , the value of F being equal to the biggest of its arguments. (This does not contradict its symmetry; for example, for $n=3$ we should have F a function of the three variables r_{12}, r_{13}, r_{23} , constant on the half-surfaces of certain cubes, its value being the edge of the cube.)

This function $F(r_{kl})$ might be associated with the measurement of the length of the needle. In order to account for the whole observed shape of a solid, the construction could be extended in an obvious way, by using as the arguments of F not the mutual distances, but the Cartesian co-ordinates of the nuclei with respect to the centre of gravity. But is this answer satisfactory?

In the case of a crystal, the elements of shape that interest us most are the angles between the various plane domains of its surface. The measurement of the angle between two crystal planes is certainly the one most frequently performed on a crystal concerning its external shape. Even an X-ray investigation of a single crystal is usually preceded by carefully orientating it with respect to a given frame; this amounts to angle measurements of a similar kind. For all these purposes no measurement of length in the crystal is required, nor is any usually made. It is hard to see how the accepted theory would associate a Hermitic operator with this very common kind of laboratory performance.

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Jan. 5.

Diffraction Gratings in Immersion

At the London Optical Conference in 1950, it was suggested¹ that the resolving power R of diffraction gratings might be increased by immersing the grating in a medium of high refracting index μ_i . Thus:

$$R = \frac{2W \sin \alpha}{\lambda} \cdot \mu_i, \quad (1)$$

where W is the ruled width of the grating and where α applies for the case of autocollimation of incidence and diffraction. This idea, which is a strict parallel

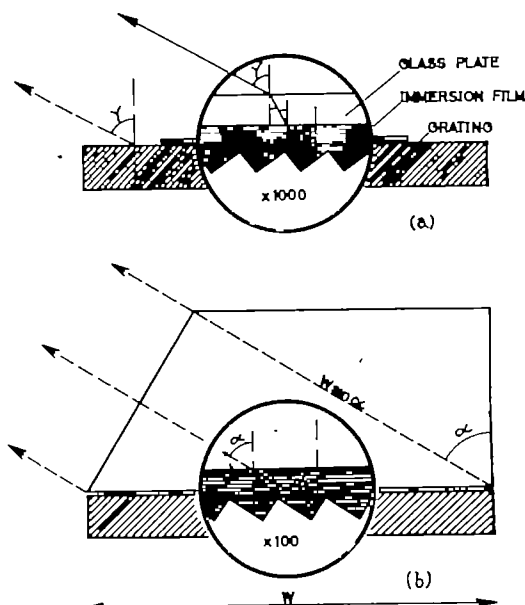


Fig. 1

to that of the immersion microscope, was further developed² in accordance with Figs. 1a and b.

If we bring a piece of coverglass into optical contact with a plane grating with an immersion film (Fig. 1a), two kinds of spectra can be observed: one produced by the uncovered grating, as indicated by the dotted line, and the other produced by the 'immersion' grating. These two spectra will coincide in all orders in accordance with Snell's law of refraction. They will, however, exhibit great differences in intensity, as the immersion spectrum is produced at a steeper angle of incidence α than the angle of incidence γ occurring at the uncovered surface:

$$\sin \gamma = \mu_i \sin \alpha. \quad (2)$$

Thus a grating characterized by a 'blaze' in an order m will have this blaze shifted into the range of $\mu_i m$ when it is used as an immersion grating. Striking illustrations of this effect were obtained from photographs of the grating surface. Thus a piece of coverglass, which was fastened to the grating by an immersion oil, appeared in bright or dark contrast to the uncovered part of the grating, when illuminated in different orders of monochromatic light.

Some experiments were also made with ruling gratings on transparent films of antimony trisulphide and zinc sulphide, evaporated in vacuum on the 'back' surface of plane glass plates, afterwards aluminizing the ruled surfaces for reflexion. These films of very high refractive indices ($\mu > 2$) were, however, very brittle, so that the grating surfaces soon began to crack. (The proper name 'refraction grating' given earlier³ refers only to this special application of the immersion principle with diffraction gratings.)

A second method of testing the immersion principle will now be reported. In the ordinary dense-ruled gratings, the blaze generally appears in the first or second orders of spectrum, corresponding to angles of incidence less than 20° . In the coarse-ruled gratings, however, the blaze sometimes appears at high angles of incidence $\approx 60^\circ$. When applying the method of immersion to a grating of this type, it is advantageous

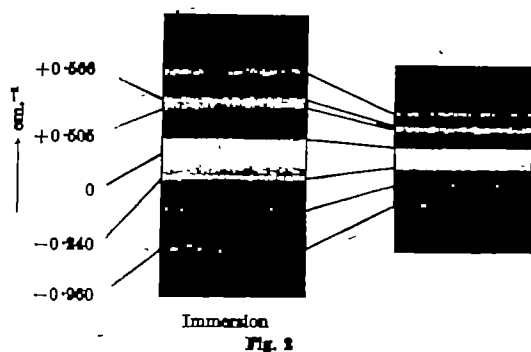


Fig. 2

to let the beam pass through a prism or a side facet in the glass plate as indicated in Fig. 1b. For simplicity we may assume that the refraction indices of the prism and the immersion oil are equal, otherwise the conditions of the system, Fig. 1b, must be treated in more detail. Fig. 2 illustrates the considerable gain in the dispersion and resolving power of a plane grating, $W = 93$ mm., when it was immersed in α -bromonaphthalene and covered by a $80^\circ/60^\circ$ dense flint glass prism. The perfect resolution of the narrow doublet $0.566/0.505$ cm.⁻¹ in the hyperfine structure of the mercury line $\lambda 4358$ indicates that the spectroscopic resolution is well above 400,000.

Further details of this investigation will appear in *Arkiv för Fysik*.

E. HULTHÉN
H. NEUBAUS

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Dec. 14.

¹ Hultén, E., Proc. London Opt. Conference 1950, p. 111.

² Hultén, E., *Ark. Fys.*, 2, 430 (1950).

Use of High Contrast in the Photography of Interference Fringes

In a recent communication, Hough and Goldsmith¹ have described a method of increasing the sharpness of interference fringes by high-contrast photography with controlled exposure. Although the technique does not appear to be widely known and I have no knowledge of any published material on the subject, the method is not new and has been in use here for a number of years.

For the case of infinite contrast, which is the only case in which the widths of dark and light fringes may be adequately defined, a curve relating black/white ratio to exposure for a single photographic process may be obtained by considering the intersection of the curves $I = \sin^2 x + A$ (light intensity) and $I = B$ (threshold at which the dark-light transition on the plate occurs), where I is light intensity, x is distance perpendicular to fringe direction and A and B are constants depending on fringe visibility and exposure. The lengths of the intercepts of $I = B$ below and above $I = \sin^2 x + A$ give the widths of dark and light fringes respectively. Fig. 1 shows a curve for 100 per cent fringe visibility ($A = 0$).

Experimentally it has been found that, over the exposure range 0-7, results are in good agreement with theory; but above this value measurement of fringe-widths becomes difficult, and black/white ratios greater than 5.5 are difficult to obtain. In order to obtain the best results in the over-exposure region,

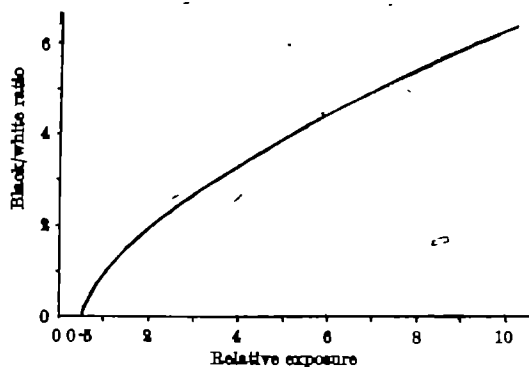


Fig. 1



Fig. 2

two points require attention. First, developer fog must not be allowed to appear; the use of an efficient stop-bath after development is useful for this. The second condition is that the fringe-spacing must not be too small. Using Ilford R.40 plates, a separation between fringes of 2 mm. on the plate appears to be necessary for the best results. With a fringe-spacing of 0.5 mm. a black/white ratio of 3.5-4 seems to be the best obtainable.

Where a double photographic process (negative and print) is used, the following technique gives good results. The negative is given an exposure of about 4 and developed to only a moderately high contrast. By printing on a contrasty material with minimum exposure, a final result with white/black ratio about 6 may be obtained.

While this type of process can give much more accurate results than are normally expected from double-beam interferometry, some care must be exercised to prevent errors due to uneven illumination. A typical interferogram is reproduced herewith (Fig. 2).

D. S. BROWN

Sir Howard Grubb, Parsons and Co.,
Walker Gate,
Newcastle upon Tyne 6. Jan. 8.

¹ Hough and Goldsmith, *Nature*, 172, 1105 (1953).

Ferroelectric Structure of Potassium Dihydrogen Phosphate

SLATER'S theory¹ of the origin of the ferroelectricity shown by potassium dihydrogen phosphate below 120° K. is based on the assumption that the proton of the O—H—O bond is situated in a double potential well. Above the Curie point, the proton is not permanently located in either well and moves between the two, giving the structure non-polar tetragonal symmetry. Below the Curie point the proton positions are ordered in accordance with the polar orthorhombic symmetry.

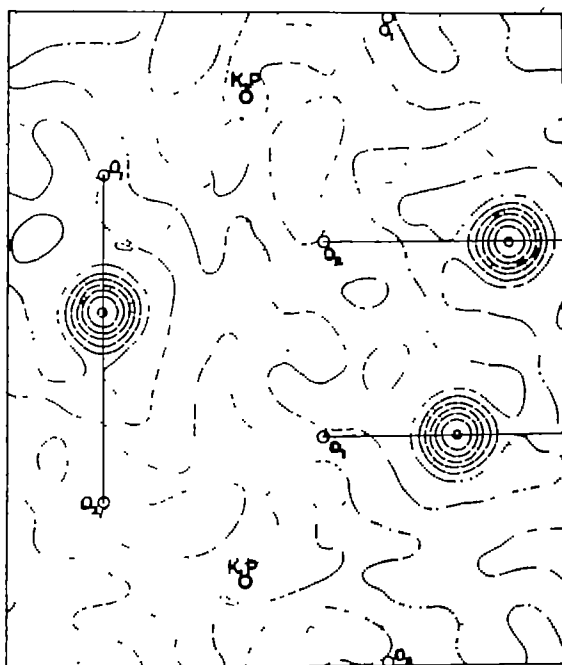


Fig. 1. Projection on (001) of the density of neutron scattering due to hydrogen atoms in potassium dihydrogen phosphate at -180°C . Contours are drawn at intervals of 50 units. Broken lines are negative contours and the zero contour is shown dotted; no positive contours appear. The small circles mark the positions of the potassium, phosphorus and oxygen atoms.

In a recent paper¹, we have discussed the structure at room temperature of potassium dihydrogen phosphate as determined by neutron diffraction. We have shown that the proton distribution is elongated along the O—H—O bond; but it is not possible to decide whether this is due to the existence of a double potential well or to a normal anisotropy of thermal agitation. If the former is in fact true, then we have found that the two minima are displaced by about $\pm 0.18\text{ \AA}$ from the centre of the O—H—O bond.

We have now obtained some results on the structure in the ferroelectric state, the crystal being maintained as a single domain by means of an electric field. We find that here the hydrogen atom is situated asymmetrically between the oxygens, in an ordered arrangement to satisfy the *Fdd* symmetry as supposed by Slater. A projection of scattering density on the (001) plane is shown in Fig. 1; this can be contrasted with Fig. 10 of our earlier paper¹, which shows the same portion of the structure at room temperature. The projection shows the Fourier synthesis of hydrogen atoms only, as obtained from the quantities $F_{\text{obs.}} - F_{\text{KPO}}$, where $F_{\text{obs.}}$, F_{KPO} are respectively the observed structure factors and those due to potassium, phosphorus and oxygen calculated from the positions of these atoms given by a direct synthesis of $F_{\text{obs.}}$. For convenience the positions of these atoms are marked by circles in Fig. 1. The hydrogen atom is displaced by $0.21\text{ \AA}$ from the centre of the O—H—O bond, the symmetry being such that throughout a single domain all the hydrogens are displaced towards, say, 'upper' oxygen atoms, O_1 , of PO_4 groups in accordance with Slater's model. On reversing the electric polarization, they are all displaced towards 'lower' oxygens, O_2 .

We find no significant movement of the oxygen atoms from their room-temperature positions in the *xy*-plane. If there is no substantial departure of the

O—H—O bond from the horizontal, as seems likely from Frazer and Pepinsky's X-ray measurements², it follows that the two portions of the O...H...O bond will be 1.04 and $1.45\text{ \AA}$, respectively.

Full details of these investigations will be presented in due course.

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Atomic Energy Research Establishment,
Harwell,
Didcot, Berks.
Nov. 13.

¹ Slater, J. C., *J. Chem. Phys.*, **9**, 16 (1941).

² Bacon, G. E., and Pease, R. S., *Proc. Roy. Soc., A*, **230**, 397 (1953).

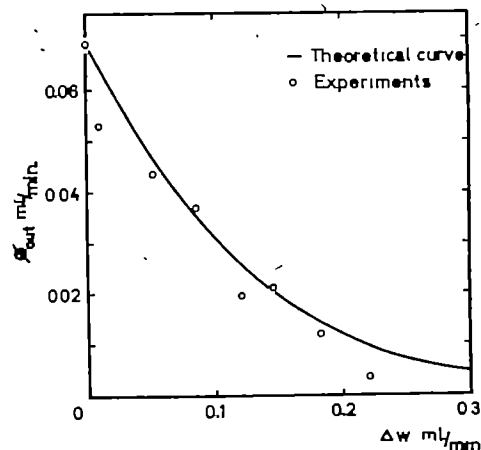
³ Frazer, B. C., and Pepinsky, R., *Acta Cryst.*, **6**, 273 (1953).

Permeation of a Membrane in the Presence of Water-Flow Induced by Hydrostatic Pressure

THE present status of the quantitative theory of membrane transport processes in the absence of water-flow has been almost fully verified by the available experimental evidence. It is also a fact that in many artificial and biological membrane systems the effect of the water-flow, though undoubtedly present, can be neglected because of its small size. In other membrane systems this may not be so. It should be emphasized that the mere knowledge of rate of flow of a volume of water through a certain area does not give the velocity of the water-flow in the membrane.

In the flux equation, the influence of net solvent-flow can be expressed as an additive flux term equal to the velocity of water-flow times the concentration of the component studied at the membrane point considered¹. The integration of the general equation describing the simultaneous operation of diffusion forces, electrical forces and the effect of fixed membrane charges as well as net solvent flow forces remains to be done. Manegold and Sol² solved the equation for an uncharged particle in a special case by employing the relation given by Hertz³. A solution for the general case, omitting only the effect of fixed membrane charges, has been suggested by Teorell⁴. In the interesting case where the ratio between influx and outflux is considered, solutions were given by Ussing⁵ and Teorell⁶.

Little attention has been given to an experimental approach to the phenomena¹. In order to try to verify the theoretical statements, the following experiments have been carried out. In a dual diffusion



chamber system, one compartment was closed and connected to a constant-pressure device. A fairly permeable cellulose filter-membrane (effective area for heavy water diffusion about 30 per cent) separated the two compartments. A constant known flow of water could be obtained and the permeation of a test substance against the flow could be measured. The accompanying graph shows the result for deuterium-labelled water as the test substance. The total flux of water against the mass flow is plotted against the net flux, which, in this case, is equal to the velocity of the streaming water times the area available for flow. The curve is plotted from the relation:

$$\Phi_{\text{out}} = \frac{\Delta w}{\exp(\Delta w \cdot \delta / A R T w') - 1}$$

where Φ_{out} is the total flux of water out, Δw is the net flux of water, A is the area available for flow, R the gas constant, T the absolute temperature and w' the mobility of the water molecule in the membrane, in this case taken to be equal to D_w/RT , where D_w is the free diffusion coefficient of water in water. δ is equal to the membrane thickness. The experimental observations seem to follow the theoretical curve quite satisfactorily (see figure).

A full report of these experiments and others in progress will be published later.

LARS GABBY

Institute of Physiology,
University of Uppsala. Nov. 6.

¹ Manegold, H., and Solf, K., *Kolloid-Z.*, **59**, 179 (1933). Williams, J. W., and Oady, L. C., *Chem. Rev.*, **14**, 181 (1934). Bloch, I., *Bull. Math. Biophys.*, **8**, 21 (1946). Rashevsky, N., "Mathematical Biophysics" (rev. edn., Chicago, 1945). Ussing, H. H., *Acta Physiol. Scand.*, **18**, 43 (1949). Teorell, T., *S. Electrochem.*, **55**, 460 (1951).

² Harris, G., *Phys. Z.*, **23**, 433 (1922); *Z. Phys.*, **19**, 35 (1925).

³ Teorell, T. (to be published).

⁴ Ussing, H. H., in F. F. Nord, "Advances in Biophysics", **12** (1953).

⁵ Teorell, T., in "Progress in Biophysics", **3** (London, 1953).

Sidereal Correlation of High-Energy Cosmic Rays

EXTENSIVE air showers have been recorded at Auckland (altitude 40 m.) during the period February 1951–February 1952 inclusive, with three counter trays each of sensitive area 2,560 cm.² placed at the corners of an equilateral triangle with 4 m. sides. About 3×10^6 events have been recorded. Averaged over the year, the results show a solar diurnal variation of 1.46 ± 0.16 per cent (first Fourier amplitude with statistical probable error), with the maximum at 2.9 ± 0.4 hr. local solar time. This correlates well with temperature.

When the number of showers occurring in half-hourly intervals of sidereal time is averaged over the year, the figures show a sidereal variation with first Fourier amplitude 1.06 ± 0.16 per cent with the maximum at 19.3 ± 0.6 hr. local sidereal time. This result is similar to the Fourier amplitude of 0.89 ± 0.13 per cent with a maximum at 22 ± 1.3 hr. local sidereal time obtained by Daudin and Daudin¹ in 1951 at the Pic du Midi for extensive air showers recorded with a different arrangement of counters.

A seasonal variation in the solar diurnal effect would give an apparent sidereal effect when the results are expressed in sidereal time and averaged over the year. In this case, provided the solar seasonal effect is the same in the southern as in the northern hemisphere, we would expect the apparent sidereal variation obtained in the two hemispheres

to differ in phase by 180° . In fact, the variations observed at Auckland (lat. 37° S.) and the Pic du Midi (lat. 43° N.) are in phase, and the maxima coincide in local sidereal time almost within the probable error. This gives grounds for believing that the variation observed is a genuine sidereal effect and is not a residuum due to seasonal changes in the solar diurnal variation.

Although the times of the maxima at Auckland and the Pic du Midi do not agree exactly, at both places the local maximum coincides closely with the time at which the Milky Way is overhead. This suggests that cosmic rays come preferentially from regions of high star density.

At Auckland the maximum is not far from the time (18 hr. local sidereal time) at which the centre of the Galaxy crosses the meridian. The declination of the galactic centre is -26° . This means that it passes daily within 11° of the vertical at Auckland, but only within 69° of the vertical at the Pic du Midi. Any effect due to cosmic rays coming from the central region of the Galaxy should therefore be much stronger in Auckland than in Europe. This accords with the fact that our sidereal amplitude is nearly three times as large as that obtained at the Pic du Midi. The results therefore indicate that more high-energy cosmic rays are observed when the centre of the Galaxy is overhead.

We cannot reconcile these results with those of Ballario, Brunelli, de Marco and Martelli², who observed dense showers on the Testa Grigia for a period of three months and obtained a maximum at about 10 hr. Central European Time, which we find corresponds to 5 hr. local sidereal time.

One of us (J. R. S.) is indebted for a fellowship to the University of New Zealand Research Committee, which also gave a grant covering the major cost of the apparatus.

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Department of Physics,
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Auckland, C.1, New Zealand.
Dec. 11.

¹ Daudin, A., and Daudin, M. J., *C.R. Acad. Sci., Paris*, **234**, 1561 (1952).

² Ballario, C., Brunelli, B., de Marco, A., and Martelli, G., *Nuovo Cim.*, **8**, 567 (1951); see also *Phys. Rev.*, **83**, 566 (1951).

Motion of the Storm-D Regions

W. R. PIGEON¹ has reported coherent variations with longitude which he interprets as motion of the "storm-D regions" once around the earth in 48 hr. This result is based on the data of about three years from each of six vertical-incidence ionospheric stations. Work at the National Bureau of Standards, however, based on ionospheric data tabulations from seventeen stations for the four years, 1949–52, does not support the hypothesis of coherent motion of such regions.

Reference will be made here to (per cent) 'probability of blackout' rather than to storm-D regions. Diurnal variation of blackout probability is determined by counting the number of instances (at each hour for the four-year period) of excessive absorption. In these cases the letter B is the standard symbol used to replace a numerical value for all the ionospheric parameters normally scaled: f_0F_2 , $h'F_2$, f_0F_1 , $h'F_1$, f_0E , $h'E$.

Blackout may often be a misnomer, since the no-echo conditions can also arise if the equipment lacks

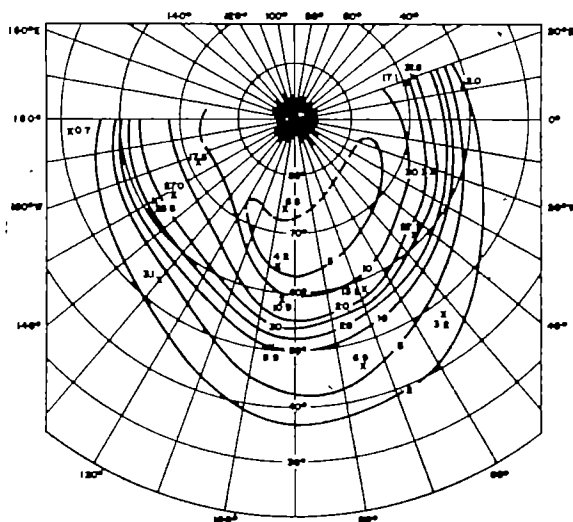


Fig. 1. Average probability (per cent) of blackout (A_0)

sensitivity and if absorption is only moderate. Moreover, Watts and Brown³ have shown recently that at Washington, for example, 'no-echo' in the 1-25 Mc./s. range may be accompanied by F -layer reflections with f_oF_2 less than 1 Mc./s., that is, at times of extremely low absorption. In general, it is impossible to differentiate among the three conditions: (1) blackout, (2) low sensitivity with moderate absorption, (3) f_oF_2 less than 1 Mc./s., by use of the tabulation sheets alone. The no-echo conditions, due to any of the three causes, is the subject of this communication, but the term 'blackout' will be used throughout. It is assumed that data from different stations are directly comparable.

The diurnal curves may be approximated (in general, quite closely) by the constant term and first harmonic of a Fourier series: per cent probability of blackout = $A_0 + C_1 \cos 15(t - \phi_1)$, where A_0 is average per cent probability, C_1 is amplitude (per cent) of the first harmonic of the diurnal variation, ϕ_1 is time (in hours) at which the first harmonic reaches a maximum (ϕ_1 , of course, may

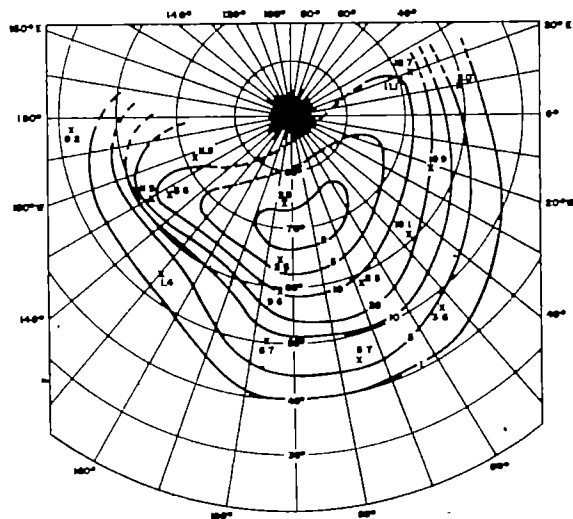


Fig. 2. Amplitude of diurnal variation of probability (per cent) of blackout (C_1)

be expressed in local time for each station or in universal time).

Contour plots of A_0 (Fig. 1), C_1 (Fig. 2) and ϕ_1 (Fig. 3) are shown. The minimum shown on the plot for A_0 (or C_1) over North America, north of the auroral zone, is perhaps surprising; but its existence has long been suggested by the relative ease of maintaining radio communications inside the auroral zone. A recent study⁴ of continuous-wave field-strength data gives additional evidence. The presence of this minimum suggests that rotation about the geographical pole is not likely, although such motion, possibly about the dip pole, is not ruled out.

The ϕ_1 plot (Fig. 3) does not suggest motion of the sort proposed by Piggott, nor does it suggest motion of any sort except that which is apparent in the case of any phenomenon depending primarily on local time. More important, however, is the fact that no simple longitudinal motion can account for the large, relatively complex latitude variations of

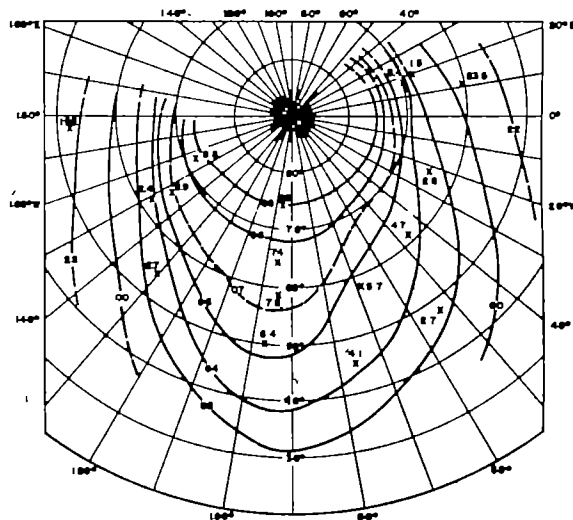


Fig. 3. Time (L.M.T.) of maximum probability of blackout (ϕ_1)

A_0 and C_1 . Motion, in a study of this kind, should be shown by comparison of plots of equal probability contours for successive hours of universal time: that is, the chart for 0000 G.M.T. should differ from that for 0100 G.M.T., etc., in such a way that speed and direction of the motion can be determined. Plots of this kind have been attempted, but appear to have little meaning and do not exhibit the motion suggested by Piggott.

It is concluded that a 48-hr. rotation of the storm- D regions is not indicated.

There is a large seasonal variation in blackout probability as well as variations with magnetic disturbance. These, as well as a more detailed account of the work referred to above, are being incorporated in a paper now in preparation.

VAUGHN AGY

National Bureau of Standards,
Washington 25, D.C. Dec. 17.

¹ Piggott, W. R., *Nature*, 171, 124 (1953).

² Watts, J. M., and Brown, J. N., International Scientific Radio Union, Ottawa, October 5-8, 1953 (accepted by *J. Geophys. Res.* for publication in March 1954).

³ Agg, V., International Scientific Radio Union, Ottawa, October 5-8, 1953 (accepted by the *J. Geophys. Res.* for publication in June 1954).

Reduction in the Loss Factor of Certain Ceramics by Heat Treatment

It has been suggested by Breckenridge¹ that one of the main reasons for the absorption of energy in a.c. fields by alkali halide crystals is the presence in these crystals of pairs of associated lattice defects on adjacent sites. Breckenridge carried out measurements on various halide crystals, and he found in some cases that it was necessary to heat-treat a crystal at a temperature within 25° C. of its melting point, following this treatment by fairly rapid cooling, in order to produce a sufficient number of lattice defect pairs for the energy absorption to be measurable.

This suggested to me that it might be worth while to attempt to reduce the dielectric losses in steatite, forsterite and other ceramics by a prolonged heat treatment at a temperature well below the firing temperature of the ceramics. The heat treatment was chosen quite arbitrarily as 60 hr. at 1,000° C. The values of dielectric constant (K) and the tangent of the loss angle ($\tan \delta$) were determined at 10 cm. before and after heat treatment. Some of the results obtained are given in the accompanying table.

Ceramic	Before heat treatment		After heat treatment	
	K	$\tan \delta$	K	$\tan \delta$
A	5.8	15×10^{-4}	5.8	4×10^{-4}
B	6.8	6×10^{-4}	6.8	4×10^{-4}
C	6.1	4×10^{-4}	6.2	9×10^{-4}
D	6.6	7×10^{-4}	6.6	1×10^{-4}
E	6.2	5×10^{-4}	6.2	8×10^{-4}
F	6.8	2×10^{-4}	6.8	9×10^{-4}
G	6.0	1×10^{-4}	6.0	4×10^{-4}
H	6.3	1×10^{-4}	6.2	4×10^{-4}
I	6.3	7×10^{-4}	6.1	2×10^{-4}
J	5.4	2×10^{-4}	5.0	2×10^{-4}
K	5.4	1×10^{-4}	5.6	3×10^{-4}

Of these ceramics, A is a British commercial low-loss steatite ceramic, the remainder are materials made in the British Thomson-Houston Research Laboratory. Ceramics B-E are forsterite, F is a wollastonite material and the remainder are steatites. The table shows that in the majority of cases the heat treatment has caused a reduction in the value of $\tan \delta$, although in one case an increase was observed. This is to be expected in view of the arbitrary way in which the heat treatment was chosen. It should be noted that many of the values of $\tan \delta$ quoted in the table are much lower than those previously quoted for ceramics of similar chemical composition. It seems likely that this type of heat-treatment process will make possible the commercial production of ceramics having much better loss properties than those hitherto available².

It is realized that, although the heat-treatment experiments were suggested by Breckenridge's work, it does not follow that the effect observed is caused by a reduction in the number of lattice defect pairs; it may well be that it is caused mainly by devitrification of the glassy phase in the ceramics. This point can only be settled by further experiments. To study the effect completely, it would also be necessary to make measurements over a considerable frequency-range and perhaps also over a range of temperature.

I am indebted to Miss J. E. J. Dods, who prepared the ceramics, and to Mr. J. H. B. Baker, both of this laboratory, who made the dielectric measurements; and also to Mr. L. J. Davies, director of

research, for permission to publish this communication.

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Adsorption of Prostatic Phosphatase on Ion-exchange Resin

In recent years the proteins cytochrome c¹, ribonuclease², lysozyme³, and haemoglobin⁴ have been successfully chromatographed on the carboxylic acid ion-exchange resin 'IRO 50'. Experiments with proteins on the sulphonated polystyrene ion-exchange resin 'Dowex 50' have also been reported⁵.

In the only case where an enzyme has been separated from a crude extract by the use of a column of 'IRO 50', the enzyme studied seems to be the only one to be adsorbed on the resin, while most of the other proteins pass right through the column. The fact that proteins often are not adsorbed on ion-exchange resins has also been utilized for desalting of proteins⁶. When, however, a protein can be adsorbed on—and later desorbed from—an ion-exchange resin the procedure might offer a fairly selective, yet mild and convenient method of purification.

This communication describes a partial purification of seminal prostatic phosphatase by adsorption on 'Dowex 50' and elution with a pH gradient. The principle of gradient elution has been outlined earlier⁷. The method is carried out here in such a way that an alkaline buffer will continuously replace the more acid starting buffer and thereby slowly change the pH of the eluting agent.

The enzyme solution used was obtained from normal human semen in the following way. The semen was diluted five times with 0.9 per cent sodium chloride solution and centrifuged at 2,000 *g* for 15 min. in order to remove the spermatozoa. The remaining solution was dialysed against a 0.2 *M* sodium acetate buffer of pH 5.4 (in the following referred to as the acetate buffer).

The phosphatase activity was determined at pH 5.5 according to Beesey *et al.*⁸, using *p*-nitrophenyl phosphate as substrate.

The resin used was 'Dowex 50- $\times$ 8', 200–400 mesh, pretreated according to Moore and Stein⁹ and finally washed with the acetate buffer. This pretreatment is essential—otherwise the enzyme is adsorbed so strongly that it cannot be eluted. After an experiment the column may be regenerated by washing with 1 *N* sodium hydroxide.

Most of the experiments have been performed on a small scale, the dimensions of the column being 8.0 cm. $\times$ 0.55 cm. The temperature was kept at 4° C. Usually, 0.3 ml. enzyme solution was applied to the column, the mixing chamber (volume 1.2 ml.) was filled with the acetate buffer and the open top chamber with a Palizsch's borate buffer of pH 7.3. The fraction collector used here shifted the tubes every 18 min., and the mean volume of the fractions was about 0.5 ml., although varying considerably during each experiment.

Fig. 1 gives the results of an experiment carried out as described above. The full line represents the

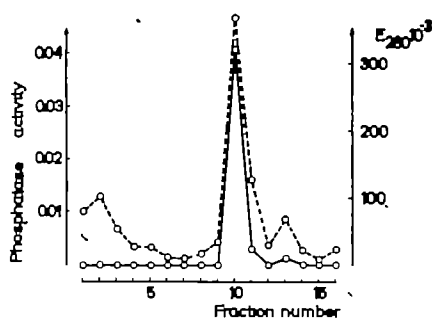


Fig. 1. Small-scale experiment with prostatic phosphatase on a column of 'Dowex 50'. Full line represents phosphate activity in moles of substrate split during 30 min. at 37° C. Dashed line represents extinction at $\lambda = 280 \text{ m}\mu$.

phosphatase activity and the broken line the extinction for ultra-violet light ($\lambda = 280 \text{ m}\mu$). As can be seen, the enzyme comes out as an extremely narrow zone and all the activity is collected in one fraction. About 75 per cent of the activity of the starting material is recovered.

The nitrogen concentration per unit activity of the active fraction shows that this chromatographic procedure gives at least a five-fold purification of the enzyme.

There are some difficulties in estimating the inactive protein material from the column. Using ultra-violet extinction, there is the risk of interference from low-molecular resin material which may be displaced from the column by proteins and therefore may appear in the eluate despite all the pre-washings. The Folin reagent was tried but gave unreasonable figures. Kjeldahl analysis has been used, but in most of the fractions (with the exception of that containing the enzyme) the concentration of nitrogen is too low to permit accurate determinations. However, both the

ultra-violet extinction measurements and the Kjeldahl determinations show that some of the inactive material passes readily through the column whereas a large part remains on the resin.

Fig. 2 shows part of the results from an experiment performed on a scale fifty times greater than the previous one. The activity and ultra-violet extinction curves for the enzyme zone are shown in Fig. 2A, while Fig. 2B gives the pH values for the corresponding fractions. The interval between the shifts of the tubes was the same as before (18 min.). The volumes of fractions 35 and 45 were about 10 ml. and 6 ml. respectively.

It is to be expected from the method that a zone will appear near the maximum of the slope of the gradient. This can also be seen from a comparison of Fig. 2A and 2B, which shows that most of the enzyme is eluted between pH 5.5 and 6.5. The ultra-violet extinction measurements and Kjeldahl determinations indicate that some inactive material follows directly after the enzyme. A buffer system with a larger buffer capacity in the effective pH region would therefore be expected to give still better separations.

London and Hudson⁶ have recently reported a purification of the prostatic acid phosphatase starting from prostate glands. One of the preparative steps they used was adsorption on calcium phosphate gel, which gives a two-fold purification. It is difficult at present to compare the purity of their enzyme with that obtained here after adsorption on 'Dowex 50'. In any event, it is felt that this adsorption procedure will be a useful complement to other preparative methods.

The work is being continued, and full accounts will be published elsewhere. I wish to thank Prof. A. Tiselius for his interest in this work.

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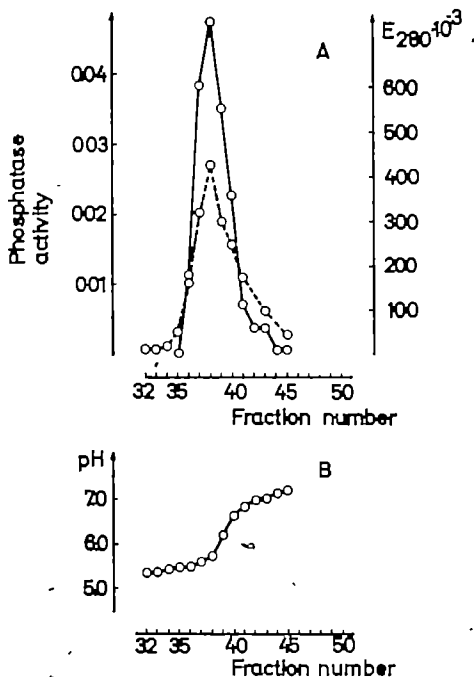


Fig. 2. Part of a larger scale experiment with prostatic phosphatase on a column of 'Dowex 50'. (A) Enzyme activity in moles of substrate split during 30 min. at 37° C. (full line), and the ultra-violet extinction (dashed line). (B) pH values for the corresponding fractions.

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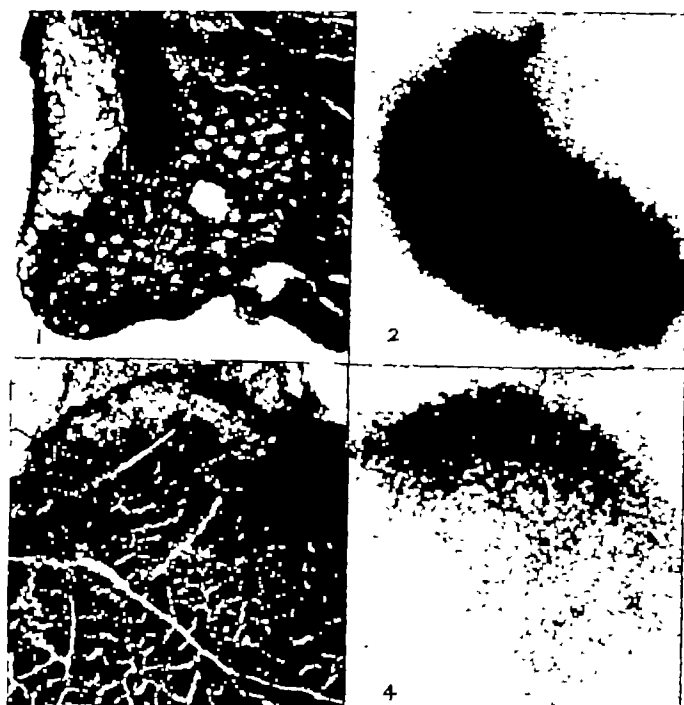
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Radioautographic Studies of the Digestive Tracts of Rats Injected with Inorganic Sulphate labelled with Sulphur-35

BÉLANGER¹ recently reported the presence of sulphur-35 in the neck cells of the gastric glands of the rat following the administration of sulphuric acid labelled with sulphur-35 by subcutaneous injection. We wish to report that we made similar observations during the course of a radioautographic study of the distribution of sulphur-35 in the rat following the administration of radioactive inorganic sulphate. The techniques employed in this work and some of the results obtained have already been reported². Sodium sulphate labelled with sulphur-35 was administered to rats by intraperitoneal injection,

and after various intervals the animals were killed, tissues were removed and contact radiosautographs were prepared. Four hours after dosing there was considerable accumulation of sulphur-35 in the necks of the gastric glands, whereas radioactive material was absent from that part of the stomach lined with stratified squamous epithelium. More intense radiosautographs were obtained from the intestinal glands (crypts of Lieberkühn). The most striking localization of sulphur-35, however, was observed in the small mucous-secreting salivary glands which lie in relation to the masseter muscle and are presumably posterior members of the molar group (Figs. 1 and 2). These results were in marked contrast to those obtained from the adjacent parotid gland present in the same sections, where the intensity of the radiosautograph



(1) Section, 50 μ thick, of a mucous-secreting salivary gland from a 190-gm. rat injected intraperitoneally 4 hr. previously with sodium sulphate labelled with sulphur-35 (approx. 3 μ c. of sulphur-35 per gm. body-weight). Hematoxylin and eosin. (2) Corresponding contact radiosautograph. Both $\times 80$. (3) Section, 50 μ thick, of the parotid gland of the same rat. Hematoxylin and eosin. (4) Corresponding contact radiosautograph. Both $\times 80$.

was in general very low, and was less for the actual glandular tissue than for the capsule (Figs. 3 and 4). Other mucous-secreting salivary glands have not yet been investigated.

The distribution of sulphur-35 observed in these experiments suggests strongly that it was secreted as sulphomucopolysaccharide. If this proves to be so, inorganic sulphate labelled with sulphur-35 should serve as a useful tool for investigating the distribution and activity of mucus-secreting cells.

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Detection of Fingerprints by the Ninhydrin Reaction

IN connexion with some recent legal proceedings, a new method for detecting fingerprints has been discovered by one of us (S. O.). The method involves the well-known ninhydrin test for amino-acids, often used in chromatography. In this method, fingerprints on paper have always been considered a great nuisance, and one is often recommended to use forceps "to avoid fingerprints"¹. In our opinion, the new method will be most suitable for detecting fingerprints on paper and similar materials. Some of the results have a wider interest, and a brief report on the new application of ninhydrin is therefore presented.

When handling a paper, a person may leave his fingerprints on it, depending on many factors such as physiological conditions, time of contact between the fingers and the paper and other unpredictable circumstances. A spontaneous fingerprint contains 98.5–99.5 per cent water, the rest being organic and inorganic compounds. Normally, the water will evaporate, leaving the rest as a fingerprint pattern containing fats, salts, amino-acids, etc. The last group of substances gives the well-known reaction with ninhydrin. Since perspiration contains water-soluble amino-acids (at least ten amino-acids have been found²) a moist finger or a moist paper is necessary if fingerprints on paper are to be made visible by the ninhydrin reaction.

Fingerprints are developed by spraying the paper with a 0.2 per cent solution of ninhydrin in acetone, followed by heating the paper in an oven at 80° C. for a few minutes. This initiates the process, and the strongest marks become visible. The pink colour becomes more intense with time, and new marks appear as the developing process matures. Details seem to have a maximum distinctness a day or two after the ninhydrin treatment.

After treating a paper with ninhydrin, it must not be touched by hand; otherwise new fingerprints will develop even if the paper is dry. This is a fact well known to everybody working on the paper chromatography of amino-acids and similar substances. In the presence of a solvent, for example water, contact with fingers gives soft pink spots with no clear lines. Even on dry paper the papillary lines become clearly visible.

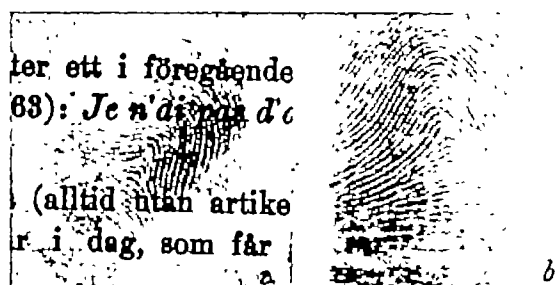


Fig. 1. (a) A twelve-year old fingerprint in a French grammar; on almost every page fingerprints could be developed by ninhydrin. (b) A fresh print as reproduced for comparison.

We have been able to develop fingerprints on many kinds of paper, some of which had not been touched for a long time. Fig. 1 shows part of a page of a French grammar which had not been used for twelve years. The owner's fingerprint can be compared with a fresh print developed on sized paper.

We are investigating the ninhydrin reacting compounds in fingerprints and perspiration. Fingerprints have also been made visible with *Amidoschwarz* (Bayer) or other reagents used for the localization of protein spots in paper electrophoresis. This indicates the presence of proteins, probably keratin.

All the details and applications of the method have not been worked out yet; but a full account of problems related to it will be published elsewhere. Part of this work has been carried out at the Institute of Biochemistry, Uppsala, and we are indebted to Prof. A. Tiselius for valuable discussions.

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Occurrence and Distribution of Sarcosine in the Rock Lobster

THE unidentified amino-acid found by us in the rock lobster (*Jasus lalandii*)¹ has been shown to be sarcosine. We are indebted to Mr. R. G. Westall for suggesting that our unknown might be sarcosine and for sending us an authentic sample for comparison.

We had previously considered this possibility, but had rejected it because the R_F values of the unidentified amino-acid in phenol and butanol-acetic acid were appreciably different from the values reported for sarcosine in the literature^{2,3} and because it did not give the colour test with *p*-nitrobenzoylchloride described for sarcosine by Plattner and Nager². However, the test also gave negative results with sarcosine in our hands, and a direct comparison of the R_F values of the unknown and sarcosine in different solvents showed them to be identical, as may be seen from the following figures:

Solvent	R_F		
	Unknown	Sarcosine Found	Literature
Phenol - water (70:30)	0.88	0.88	0.80 (ref. 2) 0.78 (ref. 3)
Butanol - acetic acid - water (40:10:50)	0.19	0.19	0.24 (ref. 3)
Lutidine - water (3:1)	0.21	0.21	—

The difference between our R_F values and those of other workers may be due to the fact that our chromatograms were of necessity run at 30°.

Final proof of the identity of the unknown was obtained by isolating sarcosine from rock lobster hepatopancreas extract by fractionation on a sulphonated polystyrene resin (nominal divinyl benzene con-

tent 4% per cent)⁴. The fraction containing sarcosine plus aspartic and glutamic acids, asparagine, proline, serine and threonine was chromatographed on a cellulose column using phenol-water (70:30) as solvent, and a fraction was obtained which contained only sarcosine and proline. This was crystallized from methanol-acetone⁵ to give chromatographically pure sarcosine, melting point 210.5-211.5° (decomp.), undepressed on admixture with the authentic sample. An examination of the infra-red spectra confirmed the identity of the two samples.

Appreciable amounts of sarcosine have been found in triphloroacetic acid extracts of the hepatopancreas and blood of the rock lobster; but only traces were found in the muscle extracts. Hydrolysates of the hepatopancreas, blood and muscle proteins did not contain detectable amounts of sarcosine. The distribution of other amino-acids in the muscle and hepatopancreas extracts will be reported elsewhere.

We are aware of only two previous reports of the occurrence of sarcosine in the animal kingdom. It was isolated from the starfish *Astropecten* by Kossel and Edlbacher⁶ in 1915, and it has recently been found in elasmobranch fishes by Shewan⁷. We have also found it in the freshwater crab *Potamon (Potamonectes) perlatus/sydneyi*, and we plan to look for it in other invertebrates.

This communication is published by permission of the South African Council for Scientific and Industrial Research.

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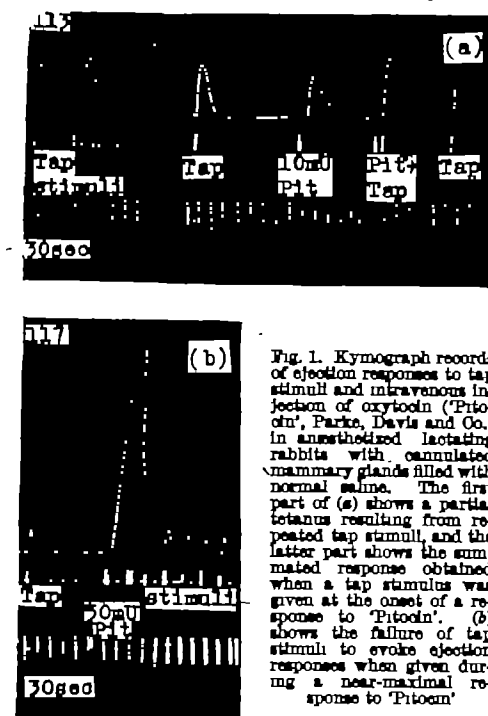
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Milk Ejection resulting from Mechanical Stimulation of Mammary Myoepithelium in the Rabbit

THERE is good experimental evidence in the rabbit^{1,2} that the normal removal of milk from the maternal mammary glands during suckling depends on a reflex release of oxytocin from the posterior pituitary gland. Histological studies^{3,4} indicate that the oxytocin induces contraction of the mammary myoepithelium, which results in the expulsion of the milk stored in the alveoli and ducts. The present experiments, which were carried out with twelve lactating rabbits, disclosed a subsidiary mechanism of milk ejection which may help to explain the small variable amount of milk yielded to the young when posterior pituitary activity is prevented by denervation of this gland, by anaesthesia⁵, and by emotional excitement⁶.

The animals were suckled by their litters prior to the experiments. They were anaesthetized with ethanol-urethane⁷, the abdomen shaved and a single teat duct of one mammary gland cannulated. Up to 5 ml. of normal saline at 37°C. was introduced through the cannula until the gland segment served by the cannulated duct was sufficiently distended to



stand out from neighbouring glandular tissue. The cannula was connected to a piston-recorder writing on a kymograph.

A sharp tap delivered with the flat surface of a scalpel handle on the cannulated segment of the mammary gland resulted after a latent period of about 1 sec. in a rise of 1–10 cm. of the fluid in the cannula, representing an ejection volume of 0.06–0.6 ml. The total duration of the response was less than 1 min. (Fig. 1). A succession of taps at intervals of approximately 10 sec. resulted in a partial tetanus and rapid onset of fatigue (Fig. 1a). The responses resembled those produced by small doses of oxytocin. When a tap stimulus was given at the onset of a near-threshold dose of oxytocin, a smooth summated response was obtained (Fig. 1a). But tap stimuli applied during a response to a near-maximal dose of oxytocin were ineffective (Fig. 1b). This result indicates that the responses to hormonal and mechanical stimuli utilize the same effector tissue (myoepithelium).

The response to tap stimuli was not affected by procaine infiltration of the overlying skin, and typical ejection responses could be elicited after removal of a portion of the skin by direct application of the tap stimuli to the exposed mammary tissue. Substitution of 4 per cent procaine for saline in the cannula also did not prevent responses to the tap stimuli. Further, section of the inguinal (external spermatic) nerve supplying sympathetic adrenergic fibres to the inguinal mammary glands did not affect the response in those glands, and electrical stimulation of the peripheral end of the nerve, or injection of adrenaline or nor-adrenaline, did not produce an ejection response. These observations favour the view that the tap stimuli activate the contractile elements directly, without nervous intervention.

Other experiments which will be reported in detail elsewhere showed that procedures which stimulate sympathetico-adrenal activity in the rabbit inhibited

the milk-ejection response to intravenous injection of oxytocin, but not the response to tap stimuli. These results provide suggestive evidence that the inhibitory effect of sympathetico-adrenal activity⁴ is mediated indirectly by mammary vasoconstriction rather than by a direct inhibition of myoepithelial contraction.

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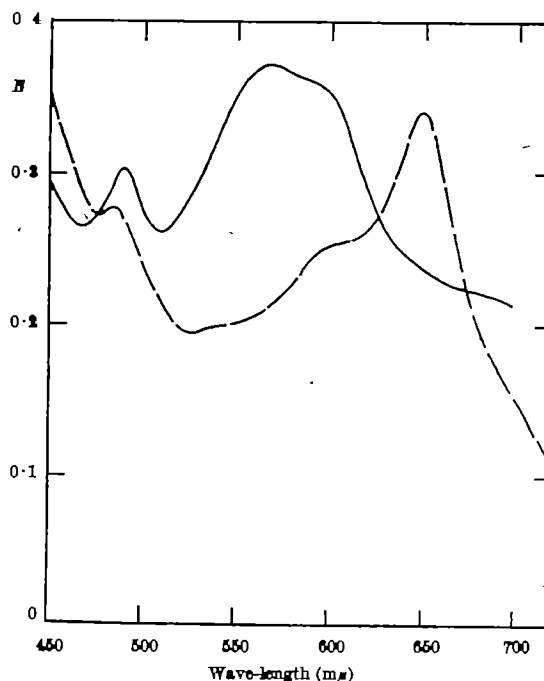
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A Billiviolin Metal Complex in Ox Bile

An ethyl acetate extract of fresh ox bile acidified to 5 per cent with concentrated hydrochloric acid yielded a dark green waxy solid on taking to dryness *in vacuo*. Chromatography of this substance from a 2 : 10 methanol – ether solution on a column consisting of a mixture of 12 gm. of acid-washed talc and 3 gm. 'Hyflo' filter-aid gave a single grey-green band which could be partly eluted with methanol. The absorption spectrum of the eluted substance (a green solid) in methanol and in methanolic hydrochloric acid is shown in the accompanying figure. Acidification changed the colour of the solution from green to violet and shifted the absorption maximum from 646 to 568 mμ. A chloroform solution of the compound showed a strong red fluorescence in ultra-violet light. The pigment could not be extracted from



Absorption spectrum of the green pigment obtained by chromatography of an ethyl acetate extract of ox bile, in methanol (---), in 5 per cent hydrochloric acid in methanol (—)

chloroform solution with 1 per cent hydrochloric acid, demonstrating that it was biliviolin and not a bilipurpurin complex.

The zinc complex of biliviolin prepared by oxidation of a pure specimen of bilirubin showed an absorption maximum in methanol at 644 mμ shifting to 569 mμ on addition of hydrochloric acid, the colour of the solution changing simultaneously from green to blue-violet.

Biliviolinoid pigments have been observed in dog bile¹ and in gall-stones², but have been considered to be almost certainly secondary oxidation products of bilirubin. It is unlikely that the biliviolinoid pigment found in ox bile arises in this way, as its typical absorption spectrum has been found in association with an undistorted bilirubin curve. This suggests that the pigment occurs *per se* in the bile, as oxidation has been found always to be accompanied by distortion of the bilirubin spectrum. Such a compound would probably occur normally in bile in the form of a trace metal complex, for a number of such elements are known to be excreted mainly in the bile, and the pH of ox bile (7-8) is such as to allow the formation of metal complexes.

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¹ Beck, A., *Wien. Klin. Wochs.*, 8, 617 (1896).

² Fischer, H., Hiltner, H., Lindner, F., and Pittner, B., *Hoppe-Seyl. Z.*, 160, 44 (1925).

Stearolic Acid, an Essential Fatty Acid?

ACCORDING to Bernhard¹, stearolic acid (Δ^8 -octadecynoic acid-1; $\text{CH}_3-(\text{CH}_2)_7-\text{C}\equiv\text{C}-(\text{CH}_2)_7-\text{COOH}$) has vitamin F activity, since this acid, when mixed throughout the diet in the form of its ethyl ester, prolongs the life of vitamin F-deficient rats.

This result is in contradiction with our investigations², in particular with the '6,9(term.)-hypothesis'. According to this hypothesis, the presence of two double bonds at the 6,9(term.)-positions of fatty acids (that is, double bonds at the 6:7- and 9:10-positions when numbered from the terminal CH_3 -group) is essential for vitamin F activity. The known essential fatty acids, namely, linoleic, linolenic and arachidonic acid, are all characterized by this 6,9(term.)-configuration. On assaying a large number of fatty acids, it appeared that acids which do not have this characteristic are inactive, and further, three new essential fatty acids were found, namely, $\Delta^{10,12}$ -nonadecadienoic, $\Delta^{11,14}$ -eicosadienoic, and $\Delta^{6,9,12}$ -octadecatrienoic acid, all characterized by the occurrence of double bonds at the 6,9(term.)-positions.

The activity of stearolic acid has now been investigated by means of our new method³ for the standardization of vitamin F. Using this method, male weanling rats received a limited amount of drinking water—14 ml./day/animal. The food was given in the form of a fat-free sucrose diet. The preparatory period lasted for seven weeks, and was followed by a four-week test period.

Five times per week 0.2 ml. of the various preparations was pipetted to groups of twelve and twenty-four animals respectively, except the control group (eleven animals) which received nothing. The groups forming the reference standard received various doses

of sunflower-seed oil, which, if necessary, were made up to 0.2 ml. with fully hardened coconut fat, which contains no linoleic acid. The stearolic acid was administered as the ethyl ester. The stearolic acid ester was prepared from oleic acid by bromination to dibromo-oleic acid, followed by dehydrobromination with aqueous potassium hydroxide. The stearolic acid thus obtained melted at 47.2-47.3° C., was free from bromine and optically pure. It was esterified in ethanol/sulphuric acid.

Probably as a result of the longer preparatory period (normally five weeks) some of the animals died. Moreover, a number of the animals developed lesions at the tip of the tail. In its final stage the lesion amounted to a complete necrosis of the tail tip; this stage was assigned the figure 3, while 2 and 1 represented less serious stages, and 0 the normal tail.

The data on the mortality, the tail lesions, and the change in the body-weight during the four-week test period are collected in Table 1. Owing to the mortality, the data regarding the change in the body-weight relate to the surviving animals.

Table 1. MORTALITY, EXTENT OF TAIL LESIONS, AND CHANGE IN THE BODY-WEIGHT OF VITAMIN F-DEFICIENT ANIMALS RECEIVING DIFFERENT DOSES OF SUNFLOWER-SEED OIL AND STEAROLIC ACID DURING A PERIOD OF FOUR WEEKS

Preparation	Dosage (day/animal)	Mortality	Mean stage tail lesions	Change in body-weight (gm.)
Control	nil	2/11	0.44	-5
Sunflower-seed oil	10 mgm.	0/24	0.00	+18
"	50 "	0/24	0.00	+70
"	182 "	0/12	0.00	+86
Stearolic acid (ethyl ester)	172 "	9/12	0.92	-38

In the sunflower-seed oil groups, no deaths or tail lesions occurred, while a distinct growth reaction was observed. Of the controls, three out of eleven animals died, the mean tail lesion was 0.44, and the body-weight of the group decreased slightly (-5 gm.). Of the twelve animals which received the ethyl stearolate, nine died (significant with regard to the control group), while the tail lesions (stage 0.92) were more serious than in the control group. The stearolate did not give any improvement in the body-weight, but quite the reverse, for a significant decrease in weight was found.

A similar growth retardation in vitamin F-deficient animals has also been observed by Holman⁴ with conjugated linoleic acid, as well as in our own investigations² with a number of other fatty acids, both saturated and unsaturated.

Summarizing, the present investigation has made it clear that stearolic acid is not able to improve the survival time, tail lesions or growth of vitamin F-deficient animals; on the contrary, it affects them adversely.

I wish to thank the management of Unilever N.V. for permission to publish this work; and Mr. Sparreboom for the preparation and Mr. Duin for the esterification of the stearolic acid.

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Rickets in Sheep

Elliott and Crichton¹ claimed that 'bent-leg' is of widespread distribution in Scotland. They found that cod-liver oil added daily to the diet of young rams less than a year old prevented the appearance of the rachitic condition. These observations were confirmed by Auchincloss and Fraser² and by Dunlop³. Recent experimental work by Ewer⁴ has shown that the rachitic condition occurring in Welsh lambs brought to Cambridge could be prevented by the administration of a single dose of vitamin D₃ (25 mgm. calciferol in 10 ml. arachis oil) given orally to each animal. The protective action of this large dose lasted approximately two months.

On December 20, 1951, at Dalvine Farm, Ayrshire, thirty-eight ram hogs reared on low-ground pasture from four months of age were individually numbered and weighed. The animals were allotted at random to two groups. One group comprising twenty animals (group A) received by mouth two million i.u. vitamin D. The remaining eighteen ram hogs were retained as controls (group B).

The extent of the pasture on which both groups of animals grazed together was 15 acres, which had been ploughed and re-seeded in 1950.

Blood samples drawn from the jugular vein were obtained from ten animals in each group on January 12, and again on February 9, 1952, when the live-weight of the animals in both groups was again determined. The results are shown in Fig. 1. It will be observed that the animals which received supplementary vitamin D in December made a larger gain in live-weight than did the control group.

While vitamin D has been shown to have no effect on growth-rate when ram hogs already have a sufficient store of the vitamin, half the severely rachitic animals lost weight during the experiment. The late development of the condition in the animal which made the greatest gain in live-weight in the undosed group shows clearly, however, that it is necessary for the animal to increase in live-weight before 'bent-leg' appears. Once rachitic symptoms develop, the animal is unable to move about and feed normally, at pasture or at the trough; consequently, a marked fall in live-weight rapidly follows.

The results of the blood analyses (Fig. 2) showed that whereas the serum calcium level of the dosed group was 11.3 mgm. per 100 ml., the corresponding figure for the control group was 6.78 mgm. calcium. A marked difference was also obvious even a month after dosing in the level of the blood phosphate in the two groups. The figure obtained in the undosed controls was less than 4 mgm. phosphorus per 100 ml.

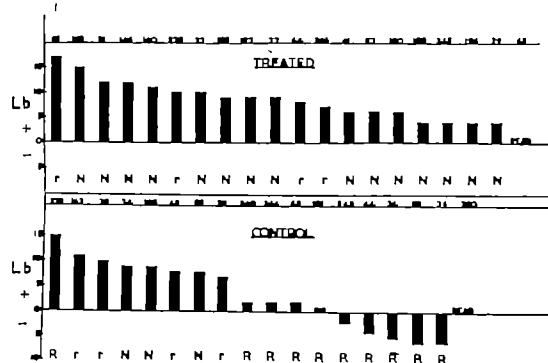


Fig. 1. Live-weight gains from ram hogs during December 20–February 9. N, normal; r, rickets; R, severe rickets

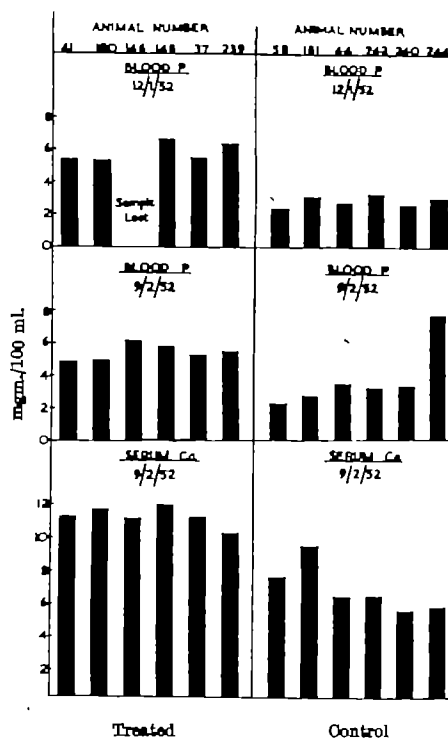


Fig. 2. Blood inorganic phosphorus and serum calcium levels of experimental animals

blood in all cases. In the dosed group, however, the blood analyses showed that the level of blood inorganic phosphorus was greater than 5 mgm. per 100 ml. in every animal. The clinical condition of five treated animals a month after dosing indicated, however, that the rachitic condition was beginning to appear.

Dosing of all the animals on February 9 with two million i.u. vitamin D₃ resulted in recovery and normal health and growth in the affected untreated controls.

It is now general practice in the south of Scotland on hill farms to administer a large dose of vitamin D₃ to the young rams about mid-December and again early in February. At all experimental centres in this area (seven), two administrations during the winter have been found to be necessary.

This treatment has been found to be sufficient to prevent the appearance of the rachitic condition 'bent-leg' during the winter months.

GEORGE DUNLOP

West of Scotland Agricultural College,
Auchincruive, Ayr. Nov. 19.

¹ Elliott, W., and Crichton, A., *J. Agric. Sci.*, 16, 66 (1926).

² Auchincloss, D. W., and Fraser, A. H. H., *J. Agric. Sci.*, 23, 560 (1933).

³ Dunlop, G., *Proc. Nutrit. Soc.*, 4, 60 (1945).

⁴ Ewer, T. K., *Brit. J. Nutrit.*, 5, 287 (1951).

Cytology of Meiosis in *Matonia*

Matonia pectinata R. Br. is one of the best known examples of a very ancient relict type among living ferns. As is well known¹, the fossil record goes back at least to the Cretaceous period and it extends geographically into the present Arctic Circle, yet the living species is confined to a few isolated mountains in western Malaysia.

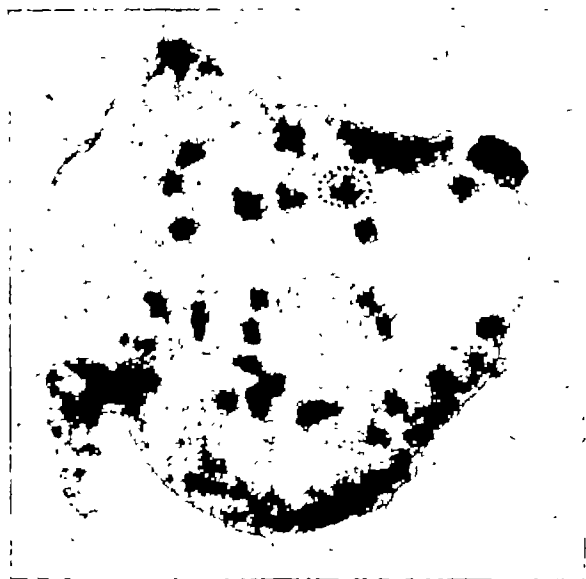


Fig. 1. First meiotic metaphase in a spore mother cell of *Matonia pectinata* photographed with a dry lens in the original acetocarmine mount to permit all the chromosomes present to be recorded in one focal level. The two bodies surrounded by dotted lines are not chromosomes. There is one nucleolus. $\times 1,000$. $n = 26$

Matonia is at present so specialized in its ecological requirements that it has never been successfully established in cultivation although the spores have recently been germinated by Miss Alma Stokey, who has described the structure and development of the prothallia².

The opportunity to study meiosis in this species arose through the co-operation of Prof. R. E. Holttum, of the University of Malaya, who, while conducting a field-course for his own students at Fraser's Hill (Selangor-Pahang boundary) in September of this year, used the opportunity to fix sporangia in the field and to post them to me. *M. pectinata* grows sparingly on Pine Tree Hill (4,800 ft.) just below the summit. Fixings were made on September 26 in 1:3 acetic alcohol which had been taken out from England ready mixed on September 9. The material was posted from Singapore on October 3; it was received in Leeds on October 8 and the observations were completed a week later.

The stages of meiosis seen include several cells in early diakinesis and metaphase I and one damaged cell in anaphase I. All the less-perfect cells gave counts of the order of 25; but, as is demonstrated by Fig. 1, the chromosome number in the best cell obtained is unequivocally 26.

It is gratifying to note that 26 was also the number put forward by Stokey and Atkinson³ on the basis of some mitotic cells in sectioned prothallia.

It is not possible to discuss the significance of this number in detail here; but it is perhaps worth mentioning that before this result was known two species of the *Dicranopteris* section of *Gleichenia*, from Malaya and Ceylon respectively, had independently given counts of 39 and 78⁴. Since *Gleichenia* has a fossil record of the same type and age as that of *Matonia* and has, moreover, long been thought to be related to it, it is perhaps not mere coincidence that both genera should possess chromosome numbers which are multiples of the same number, namely, 13.

This subject will be discussed further in a forthcoming paper by I. Manton and W. A. Sledge on the cytology of the ferns of Ceylon. *Matonia* does not, however, occur in Ceylon, and it is therefore perhaps desirable to record the facts for it in a separate note in view of the exceptional botanical interest of the genus.

I. MANTON

Botany Department,
Leeds University.
Dec. 31.

¹ Bower, F. O., "The Ferns", 2 (Cambridge, 1926).

² Stokey, A. G., and Atkinson, L. R., *Phytomorphology*, 2, 138 (1952).

³ Manton, I. (unpublished).

Chlamydo-spores and Survival in Soil Fungi

MANY of the fungi found in soil are centred around particles of organic debris^{1,2}, and from these food bases the fungi may spread into the soil matrix to a greater or lesser extent³. It is not known how far the fungi in the soil are dependant upon the undissolved organic matter or to what degree the nutrients in the soil solution support their growth. The work described in this communication forms part of an investigation into this question. The dilute solutions in which the fungi were grown were based on the formula given by Erikson⁴. To this inorganic artificial soil solution dextrose was added to give solutions varying from 0.005 gm./l. to 0.02 gm./l., so that the solutions might simulate a considerable range of true soil solutions. A 0.2-ml. drop of the dilute nutrient solution was placed on the surface of a clean microscope slide resting on a bent glass support in a Petri dish, the base of which contained 5 ml. sterile distilled water. A loopful, containing 20-25 conidia, of a washed spore suspension of the fungus under test was added to the culture drop, and the dishes incubated on the laboratory bench at 17.0-24.4° C. Microscopic observation of the subsequent development was made over a period of fourteen days, after staining with acid fuchsin/lactophenol. *Botrytis cinerea* Pers., *Mycoogone perniciosus* Magn., *Trichoderma viride* Pers. ex. Fr., *Trichothecium roseum* Link., *Fusarium caryosporum* Schl. var. *oubense* (R. F. Sm.) Wollenweber and Reinking, and *Stemphylium sarcinaeforme* (Cav.) Wilts. were the fungi used.

The amount of growth produced in the artificial soil solutions varied with the concentration of dextrose, but the morphological features of the colonies were identical in all the artificial soil solutions. In *Trichoderma*, *Trichothecium*, *Fusarium* and *Stemphylium*, growth was strong and macroscopically visible. In *Botrytis* and *Mycoogone* the mycelium was more tenuous, and branching of the hyphae was sparse. In all cases, growth was continuous throughout the period of observation and the cytoplasm stained deeply. Sporulation occurred in *Trichothecium*, *Fusarium* and *Stemphylium*. Control cultures of *Mycoogone*, *Trichothecium* and *Fusarium* in glass-distilled water produced germlings with short, unbranched, attenuated germ-tubes, the cytoplasm of which was disrupted and unstaining. On plating out these cultures it was found that no viable structures remained after seven days. The spores of *Botrytis*, *Trichoderma* and *Stemphylium*, however, produced small colonies characterized by the presence of terminal and intercalary swollen cells. These bodies

had a distinct double wall and the contents stained deeply in contrast to cells of the same colony with normal diameter which contained only unstaining, disrupted cytoplasm. Little further growth occurred after this stage had been reached, but on plating out the cultures normal colonies developed on the agar and, on inspection at an early stage, were seen to originate from the swollen cells of the distilled water cultures. The characters of these swollen cells agree with the criteria of chlamydo-spores as given by Langeron*.

A Seitz-filtered solution obtained from soil by displacement with water, when used as the culture liquid in place of artificial soil solution, gave restricted colonies which were morphologically identical with controls in glass-distilled water. The three fungi which had produced chlamydo-spores and remained viable in distilled water behaved in the same way here, while those which retained the usual morphology died. In a Seitz-filtered 1:5 water-extract of the same soil, development followed closely that taking place in Seitz-filtered artificial soil solution, growth continuing without the production of chlamydo-spores. The total dissolved solids in the displaced solution were greater than four times those in the water-extract, and the oxidizable organic matter greater than five times that in the water-extract. It seems probable that the characteristic development in the displaced solution was due to the presence of an inhibitory factor rather than to a shortage of nutrients.

Seitz-filtered displaced soil solution was amended with sterile dextrose solutions to give two concentrations of enriched displaced solution containing 0.01 gm./l. and 0.05 gm./l. dextrose respectively. Displaced soil solution which had been diluted an equal amount with sterile distilled water was used as control, and colonies in this solution developed exactly as in the undiluted solution. In both enriched solutions *Botrytis*, *Mycocone*, *Fusarium* and *Stemphylium* developed as in the artificial soil solutions. *Trichothecium* showed a partial inhibition with production of malformed conidiophores in the solution containing least dextrose. *Trichoderma* showed evidence of inhibition in both enriched solutions by the production of chlamydo-spores, and a reduced but continuous growth-rate. The level of dextrose in the enriched solutions was greater than that in the artificial soil solutions, yet in some cases the inhibition was still observed. The poor development in the displaced solution, then, is not due to lack of energy substances. In a displaced soil solution which had been autoclaved at 121° C. for 20 min. before Seitz-filtering, normal growth of a type morphologically identical with that found in the artificial soil solutions was obtained. The growth-rates of colonies in this solution were comparable with those of colonies in artificial soil solutions. This suggests that the abnormal development in the unautoclaved displaced soil solution was due to the presence of a naturally occurring toxin which is removed or destroyed by the heat treatment.

Concentrated washed suspensions of spores of *Botrytis*, *Trichoderma* and *Stemphylium* in distilled water were prepared with a spore density of 1.6×10^6 /litre. Drops of these suspensions were used as culture drops in an experiment to discover the effect of increased population density on the development of chlamydo-spores. Controls with 20-25 spores in each culture drop were set up in the normal way. Chlamydo-spore formation was greatly increased in all

three species and was associated with a corresponding decrease in hyphal development. Under these highly populated conditions, in fact, the colonies were largely composed of numbers of chlamydo-spores loosely held together by short lengths of moribund hyphae. In a further experiment to determine the effect of adverse conditions on the morphology of fungi of poor nutritional status, cultures of the six fungi were set up in drops of artificial soil solution in the usual way and immediately inoculated with a 23-hr. broth of an aerobic, non-spore-forming bacillus previously isolated from soil. Four of the test fungi were unaffected by the presence of this other organism and continued growth in a normal manner. Germination of *Trichoderma* and *Trichothecium* was considerably reduced by the treatment. *Trichoderma*, which had the capacity to produce chlamydo-spores, developed these bodies and remained viable with little further growth, while with *Trichothecium* the germ-tubes became markedly attenuated and ceased to grow after the second day. After four days the cultures of this fungus failed to produce colonies on plating out.

From these results it appears that, in three of the six fungi used, chlamydo-spores were produced in response to an adverse environment, being absent under favourable cultural conditions. Morphological features of this type have been reported to develop under sub-optimal conditions by other workers. Elliott† noted a darkening and a nodular development on fungal hyphae growing in the presence of bacterial contamination. Koch‡ observed that chlamydo-spores were formed by *Dibotryon morbosum* on potato-dextrose agar only near certain other organisms, one of which has since been shown to produce an antibiotic, or when toxic inorganic salts were added to the culture. In the present study the development of chlamydo-spores was associated with the ability to remain viable under conditions lethal to fungi lacking the capacity of producing them. Venkat Ram§ found that certain bacteria stimulate chlamydo-spore formation in *Fusarium solani*. He suggested that the phenomenon was due to the production of antibiotics by the bacteria and that it might be of importance in the survival of *Fusaria* in soils. Of the three fungi here found to have the capacity of producing chlamydo-spores, *Trichoderma* and *Stemphylium* were freshly isolated from soil. The remaining four fungi had been subcultured on agar for a number of years. It is suggested that the ability to produce resistant chlamydo-spores under adverse conditions, by extending the period of survival of a fungus in soil, may increase the probability of isolation of the fungus from soil. Thus strains possessing this ability will have a greater chance of being classified as members of the soil microflora.

I wish to express my thanks to Prof. O. W. Wardlaw, under whose supervision this work was carried out.

DAVID PARK

Department of Cryptogamic Botany,
University of Manchester.
Feb. 4.

* Chesters, O. G. C., *Trans. Brit. Mycol. Soc.*, 30, 100 (1948).

† Wazou, J. H., *Trans. Brit. Mycol. Soc.*, 34, 376 (1951).

‡ Garrett, S. D., "Root Disease Fungi" (*Chronica Botanica*, U.S.A., 1944).

§ Erikson, D., *J. Gen. Microbiol.*, 1, 45 (1947).

|| Langeron, M., "Précis de Mycologie" (Masson et Cie., Paris, 1952).

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‡ Koch, L. W., *Sci. Agric.*, 15, 80 (1934).

§ Venkat Ram, C. S., *Nature*, 170, 309 (1952).

Shot-hole Disease of Stone Fruits caused by *Clasterosporium carpophilum*

PURE cultures of the fungus *Clasterosporium carpophilum* were isolated from recent infections of peach leaves and fruits. Isolation trials showed that the fungus is viable in leaf lesions from March until September. For this purpose, infected parts were washed thoroughly in sterile water and small portions of the diseased tissues were placed on corn-meal agar at 25° C. Hyphal tips were taken from the edge of the growing colonies and these were left to grow on corn-meal slants. In some cases, infected portions were sterilized using, first, 1 per cent silver nitrate solution for two minutes and then sodium chloride for 3-4 minutes and then washing thoroughly in sterile water.

Pathogenicity tests gave successful results by inoculating young peach seedlings (with 8-10 leaves) with a spore suspension of the fungus. Pricking the leaves was essential for getting clear symptoms in a week's time. High humidity was secured by covering the inoculated plants with bell-jars for three days after infection.

The rate of disease-spread was studied in the field. It was shown that the symptoms begin to appear in March (after leaf growth), the severity of the disease rises gradually until May, slows down slightly until September and then rises gradually until the end of the season.

The disease starts more severely in March after wet winters than after dry ones.

Control measures by spraying with Bordeaux mixture 4:6:60 or 4:6:100 at flowering time and at setting of fruits were not successful; neither was spraying with 20 or 10 per cent lime-sulphur at the above spraying dates.

W. E. ASHOUR
M. E. ALLAM

Faculty of Agriculture,
Shebin El Kom, Egypt. Dec. 31.

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- Cunningham, G. H., "Fungus Diseases of Fruit Trees" (Brett Printing and Publishing Co., Ltd., Auckland, New Zealand, 1925).
Welsh, M. F., *Proc. Canned. Phytopath. Soc.*, 17, 12 (1950).
Wilson, R. M., *Univ. Calif. Coll. Agric. Exp. Sta. Bull.* 608 (1937).

A Variable Morphological Character of *Trichomonas vaginalis*

SEVERAL comprehensive morphological studies of *Trichomonas vaginalis* have been published¹. In none is mention made of a striking morphological character I have observed in three different strains of *T. vaginalis*. These strains were originally isolated from vaginal material gathered at the Whitechapel Clinic from patients with vaginitis and are now growing on artificial culture media².

The character takes the form of a variable thickening and rigidity of the terminal one-fourth to one-third of one of the four anterior flagella (Fig. 1). The presence and conspicuousness of this club-like structure varies between strains and between individuals in the same strain. It is conspicuous in most individuals in the W-2 strain, where it was first noticed; conspicuous but somewhat less frequent in the W-1 strain; least frequent in the W-3 strain. In the fourth strain, obtained from Dr. M. G. McEntegart, of the Liverpool City Laboratories, and which has now been in artificial culture for more than two years, the character appears to be absent.

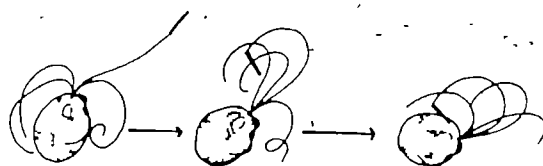


Fig. 1. Clubbed flagellum of *Trichomonas vaginalis* in an active organism

Between individuals, the character varies in conspicuousness from a well-defined rod, about two to three times the diameter of the ordinary flagellum, down to a thin structure which is the same diameter as the rest of the flagellum and is manifested solely by its inflexibility. Characteristically, a single clubbed flagellum is found on an organism. In many individuals it is absent or undetectable; rarely two clubbed flagella are found in a single set of four, but never more than two.

In dividing forms with two sets of flagella I have found several combinations of the clubbing feature: one club in each set of flagella; a clubbed flagellum in one set only; apparent absence of clubbing in both sets.

While it can be observed in those dead organisms in which the flagella are not obscured, clubbing is best seen in the living organism. A 43 × objective with a 10 × eyepiece (or 5 × for greater depth of focus) make a good combination for detecting the character. It is most striking in dark-field preparations, in which the clubbed portion of the flagellum appears brightly luminous.

The clubbed structure was also found in a fresh vaginal specimen. Though difficult to observe because of the large amount of obscuring tissue debris and the extremely active state of the flagella, clubs were present in a small number of the organisms. The structure is not, therefore, a variation arising in artificial culture, but is an intrinsic, if variable, morphological character of *T. vaginalis*.

The function of the club-like flagellar structure of *T. vaginalis* is, at this stage, open to conjecture. Thickening of the tip of a flagellum has been noted in *Leptomonas ctenocephali*³, in which the enlargement is slimy in character and serves as an organ of attachment. The flagellar club of *T. vaginalis*, however, does not appear to be slimy or sticky. Another difference between the two is that in *L. ctenocephali* the thickened flagellum is much shortened, whereas in *T. vaginalis* the clubbed flagellum is never shorter, and at times appears to be longer, than its three associated flagella.

These preliminary observations are recorded to bring this hitherto unreported character of *T. vaginalis* to the notice of protozoal morphologists as a possible additional distinguishing character for the species.

I am indebted to Dr. A. J. King, senior physician of the Whitechapel Clinic, London Hospital, for permission to obtain clinical specimens. Miss Ann Laffy made the drawing.

JOSEPH G. FEINBERG*

Lister Institute of Preventive Medicine,
London, S.W.1.
Nov. 16.

* U.S. Public Health Service Research Fellow of the National Microbiological Institute.

¹ Powell, W. H., *J. Hygiene*, 34, 145 (1936). Wenrich, D. H., *Amer. J. Trop. Med.*, 34, 39 (1944). Trussell, R. H., "Trichomonas Vaginalis" (Blackwell Scientific Publications, Ltd., Oxford, 1947).

² Feinberg, J. G., *Nature*, 171, 1165 (1953).

³ Lwoff, A., *Zentral. f. Bakt.*, 120, 498 (1930).

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, March 8

UNIVERSITY COLLEGE LONDON, DEPARTMENT OF BIOCHEMISTRY (in the Physiology Theatre, Gower Street, London, W.O.1), at 4.45 p.m.—Prof. F. Lynen (Munich): "The Participation of Coenzyme A in the Metabolism of Fat".*

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.O.2), at 5.30 p.m.—Discussion on "How can Electrical Methods Enhance Industrial Productivity".

Tuesday, March 9

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.O.1), at 1.15 p.m.—Mr. D. V. Arnold: "Libraries: Some Problems in Communication".*

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, London, W.O.2), at 2.15 p.m.—Mr. R. B. Hoare: "The Development of Spraying Machines in this Country and Overseas and Methods of Assessing their Performance".*

ROYAL SOCIETY OF MEDICINE, EXPERIMENTAL MEDICINE AND THERAPEUTICS SECTION (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Prof. G. A. H. Huxley: "Pharmacology and Experimental Medicine" (Presidential Address).

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS, LONDON CHAPTER (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.O.2), at 5 p.m.—Mr. F. F. Roberts and Mr. H. G. Bassett: "The Theory and Application of Transistors".

INSTITUTE OF THE RUBBER INDUSTRY, LONDON SECTION (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. S. B. Pickles: "Some Recollections of Events and Personalities in the Rubber Industry, 1903-1953".

ILLUMINATING ENGINEERING SOCIETY (at the Lighting Service Bureau, 2 Savoy Hill, London, W.O.2), at 6 p.m.—Mr. J. B. Collins and Mr. B. G. Hopkinson: "Flicker in Relation to Interior Lighting".

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Meeting on "Refractometry and Interferometry".

Wednesday, March 10

ROYAL AERONAUTICAL SOCIETY (at the Salle des Anciens Elèves des Ecoles d'Arts et Métiers, 9 bis avenue d'Alsace, Paris), at 5 p.m.—Mr. R. Hafner: "The Domain of the Helicopter" (the 7th Louis Blériot Lecture).

UNIVERSITY OF LONDON (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.O.1), at 5.15 p.m.—Prof. R. A. Miller (Dortmund): "Man at Work, a Physiological Analysis".* (Further Lectures on March 11 and 12.)

INSTITUTE OF PETROLEUM (at Mansion House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. A. Cameron: "Surface Failure in Gears".*

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.O.1), at 5.30 p.m.—Prof. G. H. B. von Koenigswald (Utrecht): "The Pithcanthropus Problem": March 11: "Java and Early Man"; March 12: "The Position of the South African Australopithecines".

OVERSEAS SCIENCE STUDENTS ASSOCIATION (at the Society for Visiting Scientists, Ltd., 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Prof. P. B. Medawar, F.R.S.: "Skin Grafting and Individuality".

Thursday, March 11

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Geoffrey Taylor, F.R.S.: "The Dispersion of Matter in a Turbulent Fluid Flowing through a Pipe"; Mr. J. Derbyshire: "Structure of Microscopic Waves".

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. R. W. Willett: "Mineral Resources of the British Commonwealth: Some Recent Developments".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.O.2), at 5.30 p.m.—Mr. C. W. Miller: "An 8-MeV. Linear Accelerator for X-Ray Therapy".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (joint meeting with AECON TECHNICAL COLLEGE SCIENTIFIC SOCIETY, at AECON Technical College, High Street, Acton, London, W.3), at 7 p.m.—Prof. D. H. Hey: "Developments in the Chemistry of Free Radicals".

Friday, March 12

ARLIS (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Miss D. Slocombe and Miss M. Dean-Smith: "The Use and Abuse of Sound Recording".

INSTITUTE OF PHYSICS, INDUSTRIAL RADIOLOGY GROUP (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Mr. F. I. G. Rawlinson: "The X-Ray Examination of Museum Objects".

ROYAL INSTITUTE (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. Hayne Constant, F.R.S.: "The Search for Lightness".

Saturday, March 13

NUTRITION SOCIETY (at University College Hospital Medical School, University Street, London, W.O.1), at 10.30 a.m.—Symposium on "Some Problems of Nutrition".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT (with good training in bacteriology and an appropriate qualification, and preferably with experience in the dairy industry) IN THE BACTERIOLOGY DEPARTMENT, for work on bacterial spores in milk and general creamery hygiene—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting 54/2 (March 13).

ASSISTANT LECTURER IN AGRICULTURAL ECONOMICS—The Registrar, The University, Leeds 2 (March 13).

LECTURER, Grade II, IN MATHEMATICS, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council, 1 Gordon Square, London, W.O.1 (March 15).

LECTURER IN MATHEMATICS at Fourth Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.O.1 (March 15).

RESEARCH FELLOW IN CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (March 15).

RESEARCH FELLOW IN METALLURGY—The Registrar, The University, Sheffield (March 15).

SENIOR LECTURER or LECTURER (Grade A) IN MATHEMATICS, SENIOR LECTURER or LECTURER (Grade A) IN PHYSICS, and a LECTURER (Grade A) IN BOTANY, at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.O.1 (March 22).

LECTURER (with a good honours degree and some relevant experience, preferably in the fields of reinforced concrete, soil machines or surveying) IN THE DEPARTMENT OF CIVIL ENGINEERING—The Registrar, The University, Bristol 8 (March 24).

LECTURER (with special qualifications in physical chemistry) IN CHEMISTRY, and a LECTURER (with special qualifications in organic chemistry) IN CHEMISTRY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (March 27).

SCIENTIST (with a good honours degree or equivalent, and preferably with general experience in coal chemistry and spectroscopic techniques) for work in connexion with infra-red and ultra-violet spectroscopy—The National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, Glos., quoting TTF/746 (March 27).

TUTOR (honours graduate in science) IN THE DEPARTMENT OF EXTRA-MURAL EDUCATION, University of Glasgow, for duties which will consist mainly of conducting and organizing classes in adult education—The Director of Extra-mural Studies, 91 Oakfield Avenue, Glasgow, W.3 (March 29).

LECTURER IN GEOGRAPHY—The Secretary, Queen's University, Belfast (March 31).

SENIOR LECTURER IN INORGANIC AND PHYSICAL CHEMISTRY at the University of Adelaide, Adelaide, South Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.O.1 (Adelaide, March 31).

LECTURER IN BACTERIOLOGY at the Western Infirmary, Glasgow—The Secretary of University Court, The University, Glasgow (April 3).

VIROLOGIST (honours graduate, with qualifications in plant pathology, and preferably with postgraduate experience in methods of plant virus research) AT THE SCOTCH PLANT BREEDING STATION—The Secretary, Scottish Society for Research in Plant Breeding, Craig House, Comstock, Edinburgh 12 (April 3).

LECTURER IN APPLIED MATHEMATICS—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (April 17).

ENGINEERS and PHYSICISTS, Senior Scientific Officer and Scientific Officer grades (with an appropriate first- or second-class honours degree, or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire areas, and Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.245/54/A/R.5.

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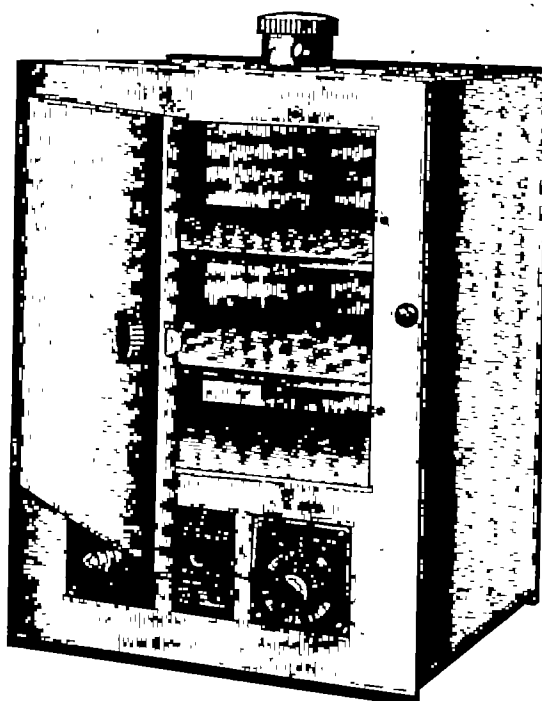
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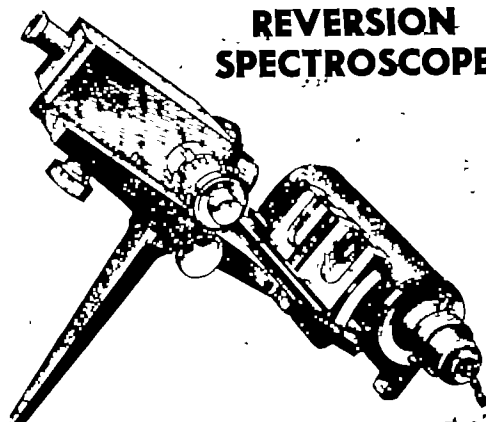
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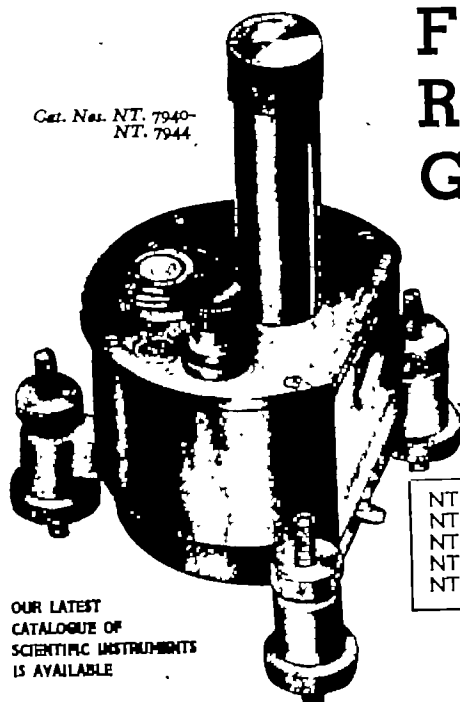


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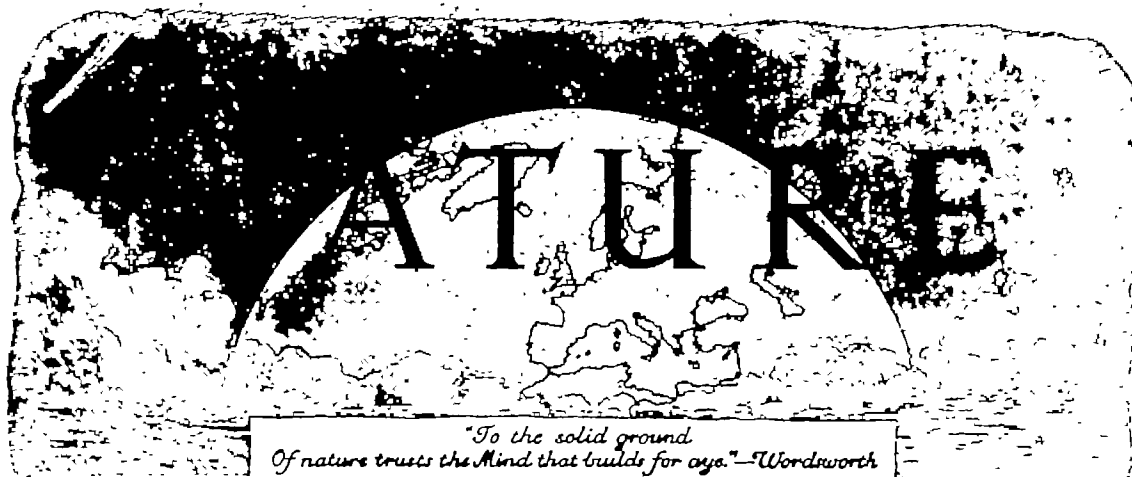
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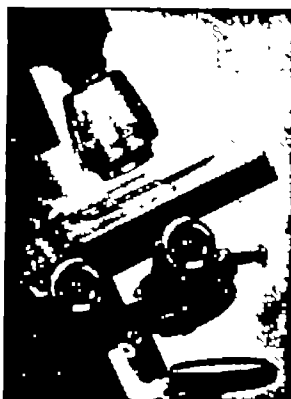


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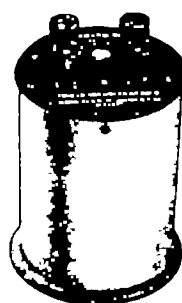
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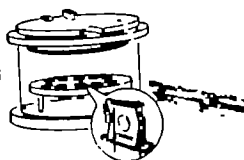
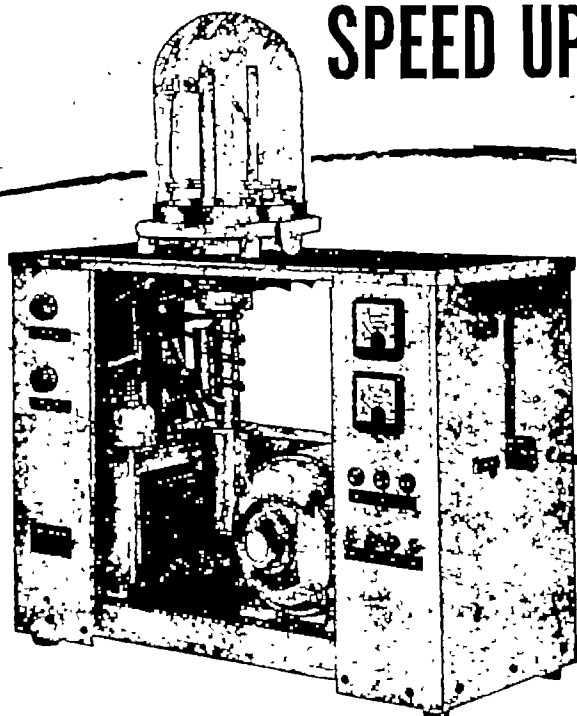
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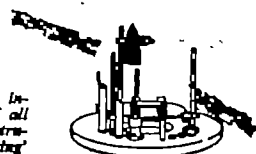
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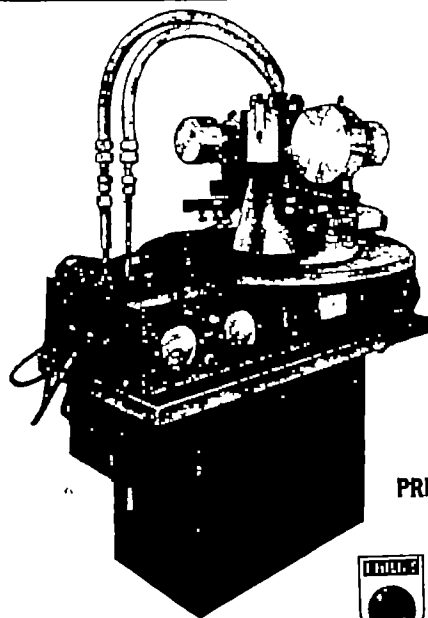
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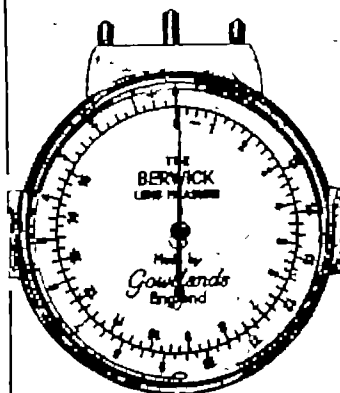


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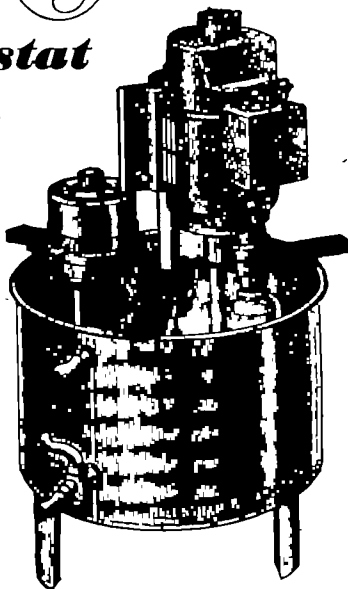
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NATURE

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DEVELOPMENT OF ATOMIC ENERGY IN BRITAIN

THE Atomic Energy Authority Bill follows the lines foreshadowed in the White Paper and in the long statement of the Government's policy which Lord Salisbury made on December 14. The Authority will consist of a chairman and not less than six or more than ten members, all appointed by the Lord President of the Council, whose responsibilities in regard to the Authority are clearly defined, and three of the members are to be persons with wide experience and proved capacity in dealing with problems associated with atomic energy. From the appointed day the Authority will be empowered to produce, use and dispose of atomic energy and to carry out research into any related subject, as well as to manufacture or handle other products required for such purposes. It will also arrange with universities and other institutions or persons for the conduct of research in atomic energy or radioactive substances, and with the approval of the Lord President of the Council and the Treasury, make grants or loans for production or research into matters connected with atomic energy or radioactive substances. Moreover, though the Authority is not, save under arrangement with the Minister of Supply, to develop or produce weapons or parts of weapons, it is explicitly free to conduct experimental work which may lead to improved types of explosive nuclear assemblies for atomic weapons.

The Authority is further empowered to distribute information relating to, and to train persons in, matters connected with atomic energy or radioactive substances. This clause to some extent appears to contemplate the Authority functioning as a training ground for the technical experts which industry will require when the industrial application of nuclear power becomes imminent. Apart from this, although the Authority to be established by the Bill is very clearly a manufacturing organization, with a degree of autonomy at least comparable to that enjoyed by other public corporations, and very considerable powers of direction for the technologists, and not as the Atomic Energy Commission of the United States, a co-ordinating body, the Bill makes even less reference to the co-operation of industry than did the White Paper. There appears to be no intention of permitting private industry to gain the all-important experience of helping with the design or operating of the key industrial plants which the Authority will control.

It would appear to fall within the powers and duties of the Lord President of the Council to give appropriate directions if at any time they should be deemed desirable. The Atomic Energy Act, 1946, already places on the Lord President the general duty of promoting and controlling the development of atomic energy, and the present Bill specifies that this duty shall include that of seeing that the Authority attaches the proper degrees of importance to the various applications of atomic energy. The Lord President may give general or particular directions after consultation with the Authority, but

is not expected to interfere in detail unless in his opinion over-riding national interests necessitate intervention. Furthermore, the powers of the Lord President, as defined in this section of the Bill, place on him the ultimate responsibility for deciding how wide and effective public discussion in this field can be by the extent to which he permits publication of the Authority's annual report.

That much was confirmed by the Minister of Works, Sir David Eccles, in moving the second reading of the Bill in the House of Commons on March 1. Sir David also referred particularly to the transfer proposed in the Bill of the powers in the Atomic Energy Act, 1946, and the Radioactive Substances Act, 1948, which relates to research, development and disposal of radioactive substances, from the Lord President to the Atomic Energy Authority. This step followed the transfer of Ministerial responsibility for atomic energy from the Minister of Supply to the Lord President of the Council, to which Parliament agreed last December. Sir David also indicated that the Lord President proposed to invite Sir John Cockcroft, Sir Christopher Hinton and Sir William Penney to be founder-members of the Authority, while continuing their executive responsibilities in sections of the Authority's work. He also stated that it had been decided to build a big, fast reactor of the 'breeder' type at Dounreay in Caithness, where survey work had already begun.

The magnitude of the responsibilities for Government policy in scientific and technological matters is made unmistakable by the Bill. Whether in fact they make impossible demands upon any one man, with his office as at present constituted, may be open to discussion. It should at least be impossible for the Lord President ever again to be saddled with extraneous departmental responsibilities, even through Ministerial sickness, and the practicability of the co-ordination of our scientific and technological effort and the disposition of the immense material resources involved in the organizations for which he is now responsible should be a central point in Parliamentary discussions on the Bill. Experience may well show whether or not some of the details of the proposed arrangements are sound, nor should it be difficult to modify them if necessary. What is all-important is effective informed public discussion of the fundamental issues involved in committing our resources on this scale.

Within the limits possible, the Atomic Scientists' Association has done much in recent months to bring to public discussion some of those questions. Others have been discussed in the United States in a series of issues of the *Bulletin of the Atomic Scientists*, which in the past year has repeatedly examined not only the security issue and its implications but also the place of private enterprise in the development of atomic energy. The Atomic Energy Commission in the United States has in fact already committed itself to the greater participation of industry, even to the extent of ownership and operation of nuclear power units and a more liberal policy in regard to patent rights. A recent (November

1953) issue of the *Annals of the American Academy of Political and Social Science* also explores in a series of articles not only such issues but also other implications of the impact of atomic energy, in the political and the industrial fields and on society in general.

The changes now proposed for Great Britain require, indeed, consideration in the widest context, not only in the light of the implications for our scientific and technical effort and resources, whether of man-power or materials, but also in the light of the effects upon our political institutions and the whole structure of society. It is perhaps even yet not fully appreciated how far secrecy has undermined the functioning of the democratic institutions by hindering the process of public understanding and control. The Government's decision to join the European Nuclear Research Organization is clearly right, as Lord Salisbury said at the anniversary dinner of the Royal Society, but less for the possibility of economy of material resources in such research, to which Lord Salisbury referred, than for the reason indicated by Dr. E. D. Adrian—the prospect of a speedier contraction of the area of secrecy.

The whole trend of Sir David Eccles's speech suggests that the Government is well aware of the importance of extending the area of public discussion as far as possible. There was no need, he said, to develop the peaceful uses of fissile material in the dark. It was intended that the Authority should have more liberty to let the outside world know what it was doing. Parliament and industry ought now to know what was going on, and, while he stressed the need for a strict security system, it was in the context that, unless there was mutual confidence in the effectiveness of security systems which guard information of such value to a potential enemy, we could not expect the essential exchange of information on the knowledge and practice of atomic weapons between members of the North Atlantic Treaty Organization. The finance of atomic energy, he admitted, was bound to be a trifle unruly and it was particularly difficult to estimate in advance how much new development would cost in any one financial year.

It should at least be recognized that the change now proposed will for the first time give Parliament some idea of the magnitude of expenditure in this field. According to Sir David, over the six years 1946–51, this exceeded £100 millions, and the Vote on Account now gives it as more than £50 millions a year, a figure which Sir David said would rise. Furthermore, although the proposals as set forth in the White Paper and in the Bill are open to the criticism that they give little indication as to how the all-important close contact and co-operation with industry are to be fostered, Sir David emphasized the Government's intention that, when a civil application of atomic energy reached the commercial stage, industry should take over, and he regarded expansion on the industrial side as a conclusive argument for the organization outside the Civil Service now proposed. Only under such an organization as is now proposed could we

hope to secure the drive and initiative, the speed and flexibility which would enable our scientists and engineers to develop fully this new source of power.

This vital factor of speed and initiative was missed by Opposition speakers in the debate, who seemed more intent on scoring party points than on constructive criticism or hammering out an agreed policy from the fundamental issues. Nor did two further important points made by Sir David receive comment. Referring to the placing of research contracts with universities and with industry, he said that the Authority would consider the education of outside scientists and engineers to be a very important part of its task. Further, following the example of the United States Atomic Energy Commission, a school of reactor technology was being set up where engineers from industry could learn about the fundamental principles of reactor design and be brought up against the many technical problems which designers have to solve.

The Government would do well to consider how far it can go within the framework envisaged by the White Paper, to make arrangements which will encourage confidence and facilitate discussion over the widest possible area of the scientific and technological effort of Great Britain. Something, of course, will depend on the appointments made to the additional posts to be created.

There are many problems on which no doubt the Government, and possibly the Waverley Committee itself, has reached no decision, and some may require time for solution. Some at least will be solved more readily by public discussion, and the Government should make it clear that there is to be no secrecy for secrecy's sake, even if in some matters care must be taken not to prejudice the fairer prospects for the Anglo-American exchange of information on atomic energy or other possibilities of Anglo-American co-operation. Neither science nor industry, however, must be held at arm's length. Frankness and confidence and full discussion within the practicable limits, generously interpreted, are the surest means of securing the co-operation of industry and of science, as they are of recruiting to the service of the Authority men of the ability and integrity required to discharge its great responsibilities with vision and energy, and to operate with skill, resource and decision.

There is this much to be added. The decision, for which there is a large measure of political agreement, to transfer to a public corporation the responsibility for the development of atomic energy must not be taken to imply that Britain is about to enjoy the benefits of nuclear fission, either for the production of power or for those other industrial purposes at which Sir John Cockcroft hinted in his Dalton Lecture on November 27. Even if the present hopes of the thermal reactors and the breeder reactor are fully realized, the application of nuclear power is still highly speculative, and much research and objective thought will be required if it is to bring advantage even to a nation placed such as Britain is in regard to fuel supplies. Isard and Whitney's recent study, while disposing of some exaggerated

ideas of the benefits which nuclear power could bring to underdeveloped areas lacking in power resources, and of the industrial disturbance likely to be caused by the adoption of nuclear energy as a source of power, left no doubt that the right decisions should be made objectively and on a factual basis*.

Their argument receives powerful support in the papers on the economic or sociological consequences of nuclear power and those on human values in the atomic age contributed to the symposium of the American Academy of Political and Social Science (*Annals*, 290; Nov. 1953), while the danger of allowing the development of atomic energy to become a party political issue can be seen in a paper by E. Douvan and S. B. Withey in the same symposium. To urge that the development of atomic energy should not be allowed to become a political issue, because there is considerable agreement that it should be entrusted to a public body subject only to broad Government control of policy and objectives, is not to suggest that the details of organization or of accountability have yet been settled, let alone agreed. It is rather to urge that those details, and above all the question of accountability, are most likely to find a satisfactory solution through an impartial, objective, all-party approach such as characterized the last debate on the nationalized industries in the House of Commons. An agreed solution of this vital question of accountability on such lines would have decisive advantages. It would give the proposed Corporation a standing which would command the confidence alike of scientist and technologist of the highest ability, whose services the Corporation must seek to enlist, and of industrial firms of repute and resources to which the Corporation could wisely entrust the development of reactors or fission products. It would, by removing the temptation to make party political capital out of minor points of difference over organization, and encouraging confidence in the effectiveness of public accountability, help any Government in power, independent of its political character, to maintain the wide and steady support from public funds which any enterprise of this kind requires before any return can be expected. Further, the support demanded for effective return, whether in defence or elsewhere, is on a scale which may well restrict the resources which can be apportioned to the social services or other sections of the national economy. The Government clearly can lead the way by making the area of public discussion as wide as possible, and putting the narrowest limits on secrecy that a realistic view of security permits; and the Opposition must respond in order to take the whole question out of the arena of politics. Grave indeed will be the responsibility of any who hinder accord and disturb the process of critical but objective inquiry and mutual understanding, upon which depend the ability of the new Corporation to recruit staff of the requisite calibre, to secure the co-operation of responsible industry and to provide the nation with whatever benefits the application of nuclear energy or fission products can bring.

* "Atomic Power." By Walter Isard and Vincent Whitney. Pp. xi+235. (London: George Allen and Unwin, Ltd., 1952.) 57s. 6d. net.

S. P. TIMOSHENKO

The Collected Papers of Stephen P. Timoshenko
Pp. xxv+842. (London: McGraw-Hill Publishing
Company, Ltd., 1953.) 140s.

History of Strength of Materials

With a brief account of the History of Theory of
Elasticity and Theory of Structures. By Prof.
Stephen P. Timoshenko. Pp. x+452. (London:
McGraw-Hill Publishing Company, Ltd., 1953.)
71s. 6d.

STEPHEN PROKOFIEVITCH TIMOSHENKO
was born on December 22, 1878. Few men have
suffered more interruption of their scientific work by
war and revolution, yet few have had greater
influence or, when they attained the age of seventy-
five, a wider circle of devoted friends to join in
birthday greetings. Six who have been associated
with him longest have produced, to celebrate the
anniversary, a volume containing all his papers
except a few in Russian never republished elsewhere,
along with an admirable photograph and a bio-
graphical preface. It appears almost simultaneously
(and in identical format) with his own monumental
"History of Strength of Materials": an amplification
of lectures given in the past twenty-five years, of
which the first chapter starts from the birth of
Galileo, the last takes the story down to 1950.
Together the books comprise more than a thousand
pages—too much material for a detailed review.

By his friends they will be studied in conjunction,
for the light they throw on the development of his
thought; more particularly the last two chapters
of the "History", in conjunction with Prof. D. H.
Young's "short biographical sketch". They cover
the first half of the present century: years in which
Klein, Runge, Prandtl and von Kármán increased
yet further the fame that Gauss, Dirichlet, Riemann
and Clebsch had brought to the University of
Göttingen. It was there, in 1906, that Timoshenko
met Klein's innovation of seminars attended both by
engineers and mathematicians; there, that at the
suggestion of Ludwig Prandtl he began the study of
what has been his prime interest ever since—the
theory of elastic instability. As it happened, in the
two preceding years he had read Love's "Elasticity"
and Rayleigh's "Sound" ("Such was the subject-
matter by which he taught himself to read English"),
and his first paper, published in 1905 (in Russian),
reveals the immense impression Rayleigh's work had
made on him. In it—for the first time, probably—a
man discussed elastic instability who realized that
"Rayleigh's method", though propounded in relation
to vibrating systems, is applicable to physically
distinct problems. Somewhat later (1909) Ritz had
extended it by largely increasing the number of the
variable parameters; and his work, too, made a great
impression on Timoshenko, shown by the reference
to it in the French version (1913) of his big memoir
of 1910 (in German)—so great an impression, that
almost invariably he has termed the extended method
the "method of Rayleigh-Ritz". It may well be that
Ritz hit on it independently, for his first paper
called it a "new method for the solution of variational
problems"; but I confess to being, with Rayleigh
("Collected Papers", 6, p. 48), "surprised that he
should have regarded the method itself as new. . .".
(Referring to his own "Theory of Sound", Rayleigh
continued: "I had supposed that this treatise
abounded in applications of the method. . ."; and

added, "in a more recent paper [1899] . . . it takes
almost exactly the shape employed by Ritz".)

For me it has been of absorbing interest to read
of events preceding those of which I learned some-
thing at the time, in letters from Timoshenko relating
to scientific publication. Though given an intro-
duction in 1918 (by Bertram Hopkinson) I did not
meet him in person until 1921; by then he had
become a professor in Zagreb, and had sent me from
there a paper which appeared in the *Philosophical
Magazine* of May 1921. Other papers followed during
1922, in which year he passed through London on
his way to his first post in the United States. He
did not (I think) contribute to the First Congress of
Applied Mechanics at Delft in 1924—the year in
which his first book was published in the United
States—but read two papers (both now reproduced)
at the Second Congress in Zurich (1926). In 1927 he
re-entered academic life as professor of graduate
mechanics in the University of Michigan, and there
began to exert on engineering education an influence
which by now is quite unparalleled: by lectures,
seminars and summer schools, and above all by the
text-books which have made his fame world-wide.

They are used everywhere, and in large measure
they remove the need for students to study his
original papers; but all will turn to his "History"
who have heard his lectures and recall their out-
standing quality of erudition. For many books have
been written on strength of materials, but few that
show even an interest in the man that have developed
it. Inevitably, in a work so comprehensive, some
pronouncements will seem questionable, some omis-
sions hard to understand; and I for one was sur-
prised to find no account of work by Baker's school
at Cambridge and Prager's at Brown University on
'limit design' of steel structures with rigid joints, no
mention—in a survey which includes experiment—
of Bridgman's work with very high pressures or of
the work of Cook and Robertson which revealed, in
mild steel, the 'drop of stress at yield'. But these
are but incidental criticisms, and what remains
from a reading as yet only cursory is delighted
amazement at the sweep and vigour of one man's
handling of so vast a theme. Many footnotes will
need revision when the "History" has been
assimilated.

R. V. SOUTHWELL

INTRODUCTION TO PILE NEUTRON RESEARCH

Pile Neutron Research

By Prof. D. J. Hughes. (Addison-Wesley Nuclear
Science and Engineering Series.) Pp. xiii+386.
(Cambridge, Mass.: Addison-Wesley Publishing Co.,
Inc., 1953.) 8.50 dollars.

THE first chain-reacting pile became critical in
December 1942, and during the decade following
that event the pile has been extensively used as a
neutron source. A new technology has grown up
with the development of 'pile neutron research', and
as the numbers working in this field increase it has
become a pressing need to have a basic text-book for
the subject. This need is met by this book by Prof.
D. J. Hughes. It is the nature—and the weakness—
of the book to describe the work that has been done
without reviewing it critically.

As is proper in dealing with a new subject, a great
deal of the material is presented at an elementary

level, but in most cases references are given which would enable a particular subject to be taken further. The author classifies his material (apart from the chapters on neutron optics) according to the type of pile facility required, and this enables him to place the wide diversity of the objects of pile neutron experiments into reasonable order. Some of the illustrative experiments (for example, those on neutron mirrors) are given in great detail, presumably because this will familiarize the student with some of the difficulties of careful and accurate measurements with the pile. However, Prof. Hughes does not stress this point. It is inevitable that, as a new field is developed, systematic errors should be present in some of the early measurements because some of the factors which influence the results are overlooked. A striking illustration of this is the frequent disagreement of various cross-section measurements (for example, the total cross-sections of boron and gold). At the present stage in the development of this new technology, it is important that a very critical approach should be made to every measurement, and that normally the experimental error quoted should be treated with reserve. This point should have been emphasized throughout the book.

A good basic introduction to the neutron and to reactors is given in the first two chapters. A practical point of some importance which is not mentioned here is the movement of the flux distribution in the pile as the control rods are moved. This is one of the reasons why separate monitoring of the intensity in beam experiments is desirable. In Chapters 3-11 a complete account of the development of pile neutron research is found. Attention is focused upon the techniques rather than the theory, and for the latter the student is invited to study the references given. The point of interest is the behaviour of the neutrons of various velocity groups.

The principles behind most of the measurements are simple, but since it is difficult to obtain accurate results, it would have been useful (in a book on Technology) if Prof. Hughes had listed the precautions which had been taken in each experiment.

Of the various points discussed, those worth emphasizing are the uncertainties in the absolute determination of neutron intensities and cross-sections, and of the detail of neutron spectra. In beam experiments one needs to have reliable collimation of fast and slow neutrons and γ -rays, and to control, by careful shielding, backgrounds due to multiple scattering of neutrons. Considerable space is devoted to the discussion of filters, which are finding increasing use as ancillaries in more complicated equipment.

Occasionally, in the interests of simplicity the subject has been over-simplified. For example, the thermal inelastic scattering is stated to be incoherent, whereas it exhibits (particularly in the energy spectrum of the scattered neutrons) pronounced interference effects. Or, again, in the discussion of the resolution of time-of-flight spectrometers, it is tacitly assumed that the time uncertainty of the instrument is a constant, whereas in many cases the time-of-flight in the detector is appreciable, and this contribution to the resolution width is a function of neutron velocity. This means that to the table of resolution widths (Table 6-2) a definite velocity should be assigned.

The book concludes with a chapter on health physics. In many cases the question of the health hazard involved in an experiment must fall upon the

experimentalist; and it would be instructive to the student to read this chapter after Chapter 2 and before proceeding to the experimental sections. A useful course on pile physics and a table of thermal neutron cross-sections are found in appendices.

In all the branches of the subject discussed by Prof. Hughes, rapid advances are being made and very soon new techniques will be in use. In spite of this, this book will remain for some years a valuable introductory text. Prof. Hughes is to be congratulated on writing with such lucidity and detail on the many and varied aspects of pile neutron research.

P. A. ECKSTAFF

INORGANIC CHEMICAL ANALYSIS

Textbook of Quantitative Inorganic Analysis.

By Prof. I. M. Kolthoff and Prof. E. B. Sandell. Third edition. Pp. xv+789. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1952.) 30s. net.

Applied Inorganic Analysis

With Special Reference to the Analysis of Metals, Minerals and Rocks. By the late Dr. W. F. Hillebrand and the late Dr. G. E. F. Lundell. Second edition revised by Dr. G. E. F. Lundell, H. A. Bright, and Dr. J. I. Hoffman. Pp. xxii+1034. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 120s. net.

THOUGH there is some overlap, these two new editions of well-known books are complementary.

In this, the third edition of their book, Profs. I. M. Kolthoff and E. B. Sandell adhere to their original purpose and provide a detailed treatment of the theoretical and practical aspects of many gravimetric, volumetric and physicochemical methods of chemical analysis; more modern developments, such as chromatography, mass spectrometry, Raman spectroscopy, fluorescence and other topics are reviewed, with adequate references to more detailed expositions. The book is intended for university students, but more experienced workers will find in it a useful summary of recent developments. As a practical reference work for the advanced or specialized worker, the book is less useful; for example, the section on gravimetric determinations deals in detail with only water, chlorine, iron, aluminium, sulphur, calcium, magnesium, phosphorus, silica, sodium, potassium, copper, nickel and limestone. One hastens to add that sections on brass, steel and silicate rocks, and numerous bibliographical references, greatly extend the scope of the book, and that throughout, when details are given, the treatment is thorough. In this thoroughly revised and modernized edition, sections rewritten or enlarged include those dealing with physical and physicochemical methods and with organic reagents.

The first edition of W. F. Hillebrand and G. E. F. Lundell's "Applied Inorganic Analysis" was published in 1929; because of its excellence and very reputable authors, the book was accepted as a standard work of reference. Though the original authors are now dead, Dr. Lundell wrote much of this new edition; his manuscript was reviewed and completed after his death by the two junior authors. The general arrangement of subject-matter in the old and new editions is substantially the same, the aim being to describe useful methods of separation and determination rather than to catalogue all

available methods, some of which may be useless for the analysis of complex substances.

For each element or group of elements, information is given concerning behaviour during the course of an 'ordinary' analysis, methods of decomposing minerals, methods of separation and methods of determination. The book has been brought up to date by appropriate omissions, additions and rewriting; special methods, such as those involving the use of the spectrograph, the polarograph, etc., receive attention, but are not described in detail. Some information is given about nearly all the chemical elements, the only elements not included being inappropriate ones, that is, the rare gases, actinium, polonium and the elements discovered during recent years. The section on the rare-earth metals contains much useful information concerning the more orthodox methods, but ion-exchange methods are not described in detail; however, this section, like all sections of the book, is adequately annotated with references to other publications. Similar comments apply to other parts of the book; as examples, the dithizone method for lead, and ether-extraction methods for the separation of uranium are not described in detail. In this edition, the sections dealing with glass, bauxite and refractories have been omitted, but the classical methods used by Dr. Hillebrand for rock and mineral analysis are retained, with necessary additions.

C. O. HARVEY

A MANUAL OF SCIENTIFIC AND INDUSTRIAL INSTRUMENTS

The Instrument Manual

Second edition. Pp. vii+628+105. (London: United Trade Press, Ltd., 1953.) 84s.

THE writing of an adverse review is always an unpleasant task, but the unpleasantness increases with the size and price of the book concerned; there seems to be an instinctive feeling that a large and expensive volume should be more reliable than a small, cheap one.

The second edition of the "Instrument Manual" is designed on a large and expensive scale; the idea behind it is excellent, but the result is sadly disappointing. The manual is divided into a series of chapters each of which deals with a particular type of measurement and consists of a theoretical introduction, descriptions of the instruments available, a list of manufacturers and a list of references to the literature. The field covered is very wide and the present reviewer can only comment with confidence on the detail of one or two of the chapters, but grossly misleading and erroneous statements found on familiar subjects undermine one's confidence in the remainder.

Perhaps examples from one of the more unfortunate sections might be quoted here (p. 56, Polarimetry): "Polarisation. To understand polarisation it is necessary to regard light as being a wave motion in more than one plane, e.g. there will be transverse vibrations as well as those in the direction of travel of the wave. The effect is indicated simply in Fig. OP 11. If it should be possible to remove one of these modes of vibration, the wave is said to have become plane polarised". The figure mentioned is said to represent a wave travelling along the x -axis of a system of co-ordinates and shows two sinusoidal waves, one along z and one along y , at right angles

to it. Later in the paragraph we find the statement: "If y becomes zero, the wave can be said to be plane polarised . . .". Towards the end of the following section we read: "If the plane polarised light emerging from a Nicol prism is allowed to fall on a second prism with its principal plane parallel to the first, the beam is split into two components, one of which, as in the first Nicol, is transmitted. If the second prism is rotated, it will be found that the intensity of the light decreases to a minimum when the principal planes are crossed at an angle of 90° . The intensity is thus *proportional to the angle of rotation*" (the italics are the reviewer's). These statements surely need no comment.

In addition to serious errors of this type, the book contains a large number of paragraphs which give no useful information at all and which might very well mislead a person with no previous knowledge of the instrument described. An example of this is the description of wet- and dry-bulb thermometers on p. 531. It is quoted in full: "These are mercury-in-glass thermometers in which the bulb is circular, and consist of the normal thermometer stem encased in an outer glass sheath, terminating at its upper end in a glass button for suspension purposes. The sheath not only protects the graduation against damage but prevents the condensation of moisture on the divisions or figures of the scale. At the lower end it is fused to the thermometer proper between the bulb and the lowest graduation". Such a description would certainly merit no marks at all in an examination at even the lowest level.

Some of the sections seem to be incomplete and lack continuity, as though they had been made up by stringing together the work of different writers and draughtsmen without proper co-ordination. For example, in a section of the chapter on temperature measurement headed "Black Body Radiation" (which, incidentally, begins "If a piece of carbon or charcoal (i.e. a black body) . . .") we find a diagram (p. 277) of a square enclosure labelled A with a ray, starting from wall C and being regularly reflected in turn from walls D , E and B . The whole paragraph relating to this figure runs as follows: "Accepting a black body condition as standard, it is desirable to achieve this as nearly as possible in actual instrumentation. Let us consider in Fig. T.T. 64 an enclosure A at a uniform temperature with a very small opening at B . The walls of the enclosure are of a material which partially absorbs and reflects radiation. A ray starting from wall C strikes wall D . Corrections may be necessary because of temperature gradient in the tube".

It would not serve any useful purpose to give any more detailed examples. One might summarize by stating that the book is reminiscent of an examination script sent in by a reasonably good student who, in his anxiety to impress the examiner, has written down all he knows regardless of its relevance to the question, putting in padding where his knowledge fails, occasionally going off the rails altogether, and certainly leaving no time for reading through at the end. In the stress of an examination this could be forgiven, but one scarcely expects it in the second, revised edition of a book costing four guineas.

There is undoubtedly a need for a book covering this ground and a great opportunity has been missed. Let us hope that if a third edition should be contemplated, the attention of the editors will be concentrated on putting right what is already there rather than on the addition of new material.

G. A. TAYLOR

THE PROCESS OF SONG-LEARNING IN THE CHAFFINCH AS STUDIED
BY MEANS OF THE SOUND SPECTROGRAPH

By Dr. W. H. THORPE, F.R.S.

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IT has been known since the late seventeenth century¹ that the full song of some species of passerine birds shows considerable local variation in pattern; and there are many facts which point to the conclusion that some of this local variation is the expression of a 'learned tradition' and not, as most call notes seem to be, genetically fixed. Nevertheless, there is also very strong evidence with many other species that even the full songs may be primarily an expression of genetic constitution. So we get the puzzling situation that complex details of the full song may be completely inborn in many species, modifiable by learning in some and probably entirely learnt in yet others. It has been suggested that many of the apparently inborn 'recognitions'—as, for example, the visual recognition of the fellow member of the species—which play such an essential part in the organization of the social life of many animals are, in fact, acquired by a special type of learning known as imprinting, which is very rapid and the effects of which are extremely persistent. The process of song learning certainly resembles imprinting in several respects, and in any event the details of the interlacement of instinct and learning in situations such as that of song production are of interest from many points of view. This is especially true in that the restriction of learning ability to a particular period and particular circumstances is not a situation with which learning theorists are as yet very familiar; and indeed such a process raises interesting problems concerning the very nature of learning itself.

Until recently, it was scarcely possible to make much progress with the problem of song learning. Bird songs, like most other animal sounds, are difficult to describe in words, and even the most musical find it difficult to remember minute details of song without the aid of a suitable notation; so the dangers of subjective interpretation are always serious. But even if a satisfactory system of notation had been elaborated, there would still have remained the primary difficulty of perceiving accurately by the naked ear elaborate sound patterns of high frequency, high speed and rapid modulation. All this was changed, however, by the development on one hand of methods of high-fidelity 'electrical recording' on disk and of magnetic recording on tape, and on the other hand by the invention of the sound spectrograph, now known commercially as the 'Sonograph'. This latter instrument automatically provides a graphic analysis of complex sound signals that vary with time.

In operation, the sound which it is required to analyse is first recorded magnetically on the edge of a 12-in. metal disk. The disk is then revolved repeatedly at 3.3 times the recording speed, and at each repetition the signal is scanned by either a 45-cycle or a 300-cycle band-pass filter which is

shifted slightly in frequency at each repetition. The output of the analysing filter is then recorded on dry facsimile paper on a drum which revolves synchronously with the magnetic disk. The recording stylus shifts gradually along the frequency-scale in step with the scanning oscillator, thus recording the frequency components at any given instant, while amplitude fluctuations will be represented by fluctuations of intensity at the output of the filter and so will show up on the paper as lighter or darker areas—the darker regions being those of higher energy-level.

From this graphic representation, frequency, amplitude and duration can be determined with sufficient accuracy, and moreover the sound spectrogram can with practice be recognized and interpreted as a 'picture' of the sounds. It thus supplies a form of notation as well as a method of precise measurement. So it is that an entirely new field in behaviour study has been opened up, for whereas vocalizations were formerly the most difficult of all releases to investigate precisely, they have now become far more readily amenable to analysis than are many patterns of visual or olfactory stimulation. The object of the present article is to indicate some of the many possibilities of the method, and to give in preliminary outline some of the more important results so far achieved.

The method in the present study has been to record all the songs either on tape or disk, to subject them to rough preliminary 'inspection' by slowing down on re-play, and then to analyse them by transferring them to the sound spectrograph. The disk and tape machines used will deal faithfully with sounds from 50 to 12,000 cycles and from 50 to 17,000 cycles per second respectively, while the sonograph can also be adapted to deal directly or indirectly with the latter frequency-range. It has, in fact, transpired that for present purposes the range 2,000–10,000 cycles per sec. is all that need be taken into account. (For the first use of the 'Sonograph' I have been greatly indebted to the kindness and courtesy of the Superintendent and staff of the Admiralty Research Laboratory at Teddington, whose 'Sonograph' was for a long time the sole instrument of its kind in England. In particular, I would like to express my thanks to Mr. S. A. Byard and Mr. H. G. T. P. Risson. Latterly, through a generous benefaction, a new instrument has been provided specially for this and similar work at the Ornithological Field Station of the University of Cambridge Department of Zoology at Madingley. The sound spectrograms here reproduced have all been made with this new instrument.)

Work was commenced in 1950 with the inauguration of the above field station. Here was available for the first time the necessary equipment of breeding aviaries, bird-rooms for hand rearing and observa-

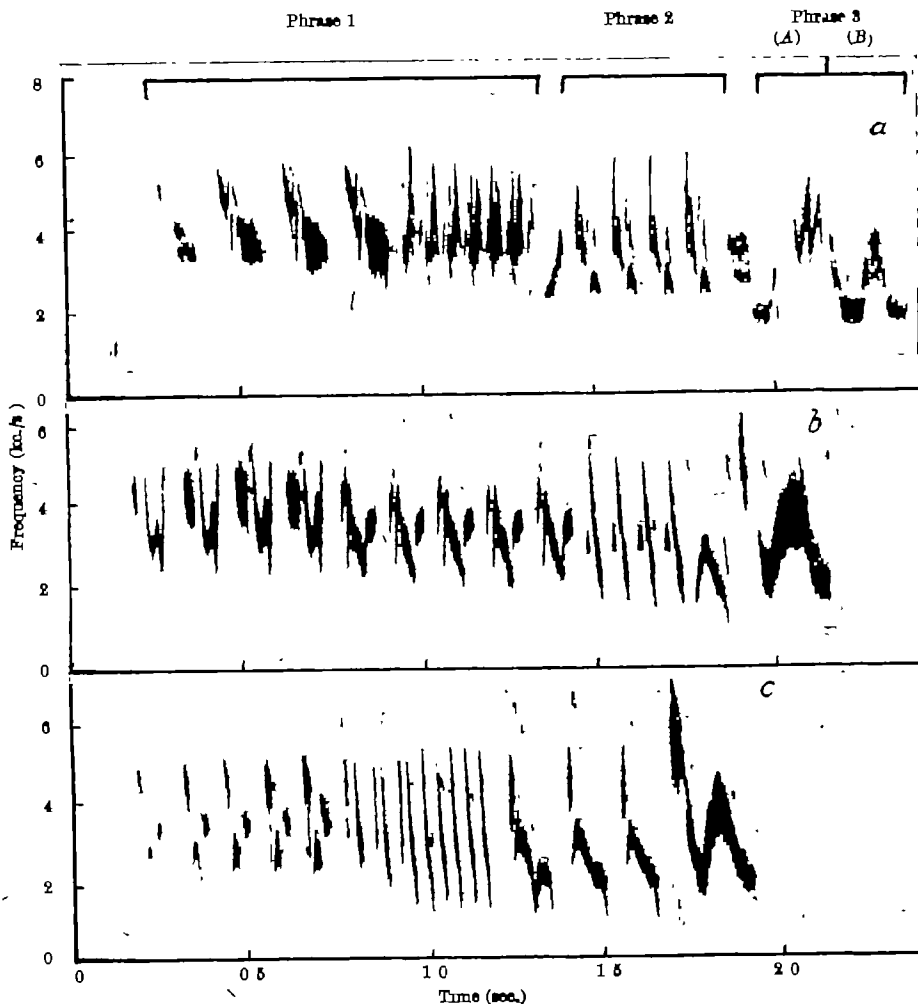


Fig. 1. Sound spectrograms of songs of control chaffinches in aviaries showing the three phrases. (a) *RWB/W*, April 20, 1953. (b) *BW/W*, May 18, 1953. (c) *BW/BEP*, March 25, 1953. Band-pass filter, 300 c./s.

tion, and sound-proof rooms for isolation experiments. The chaffinch (*Fringilla coelebs*) was chosen as the first and chief experimental species for several reasons: it has a complex and not too elaborate phrasical song of medium frequency-range and convenient length. Moreover, while the song is readily recognizable in its different forms, it is well known to have striking local peculiarities, songs of one type predominating in one area, those of another in an adjacent area³; and each individual normally sings only one type of song.

The normal chaffinch song, which is both a territorial proclamation and a stimulus to the female, consists of three phrases (Fig. 1). Phrase 1 consists of from four to fourteen notes, usually somewhat *crescendo* and normally with a gradual or step-wise decrease of mean frequency. This is followed by phrase 2, which is usually, but not always, distinct and is made up of a series of two to eight notes. These notes are of a fairly constant frequency, lower than that of phrase 1. The song concludes with a phrase 3 consisting of from one to five notes (phrase 3A), together with a more or less complex terminal flourish (phrase 3B).

In 1950 Poulsen⁴ described how two male chaffinches reared in isolation had produced songs which were abnormal in the pitch and rhythm of phrases

1 and 2, and in having a single note in place of the normal version of phrase 3B. He states that two other male birds which he caught as first-autumn juveniles also produced abnormal songs of this type. From observations of these four birds, he concluded that the chaffinch song has an inborn basis, but that the third part of the song and the pitch and rhythm of the first two parts have to be learnt. He also considered that the learning is due solely to imitation during a relatively short period of a few weeks in the early spring of their first year of adult life. It now seems clear that these conclusions need a good deal of modification.

The first step was, of course, to prove that rearing in aviaries and cages did not necessarily affect the song pattern. Thirty control birds have now been recorded in these circumstances, and so

we have a fairly precise picture of the 'normal song' (Fig. 1). The first series of experiments then consisted in taking birds which had been reared normally by their own parents, and isolating them from their first September onwards in order to study the development of their songs in the ensuing spring. It was soon found that it is not necessary for such birds to see other singing chaffinches in order to acquire normal songs. Even if such birds are caged with song birds of other species and so subject to an overwhelming 'barrage' of alien song, they can still attend only to the normal song of their species which they hear from the outside; and our experimental birds failed to show any sign of acquiring the alien songs to which they were exposed, though it is said that the chaffinch will sometimes incorporate the notes of other species in its sub-song⁵. In this lack of general imitation the chaffinch is in marked contrast with the bullfinch (*Pyrrhula pyrrhula*) and the greenfinch (*Chloris chloris*), which will learn complete songs from an alien species. In these experiments, seven chaffinches were exposed to canary song in the bird room, three to greenfinch song and two to goldfinch song in aviaries, without any abnormality resulting.

If such birds isolated as juveniles are kept out of hearing of all bird song from September until the

following May, but are allowed to hear vocalizations of other chaffinches treated in the same way, a clear difference is noticeable. Phrases 1 and 2 of the songs are practically normal, although they show much variation; but there is a slight tendency for the endings to be abnormal and to approximate to a community pattern. Twenty-seven birds were treated in this way and were isolated in six distinct groups. Fig. 2 shows the sound spectrograms of two genetically unrelated birds which have developed songs closely similar in ending as a result of being thus confined together. They are fairly representative of the general run of the experiments.

If we now repeat such an experiment using instead birds which have been hand-reared and have thus been isolated from contact with experienced birds since the first few days of nestling life, we get a very different result. Phrases 1 and 2 are now often inseparable, and phrase 3A is always lacking. Phrase 3B is often lacking also, or at most is represented by a single 'squeak' of fairly steady pitch though often of considerable frequency-range. Each isolated community of such birds builds up during the period February to April inclusive an entirely individual but extremely uniform community pattern, the resemblances throughout the song being so close that it is often very difficult to distinguish the songs of the different members of the group one from another even when subjected to a detailed analysis by the sound spectrograph. Figs. 3, 4 and 5 show the sound spectrograms of such groups of birds. The first pair (Fig. 3) were kept together in isolation during 1951-52 and had no contact with any other birds at all. The second pair (Figs. 4a and b) were similarly isolated 1952-53, while Fig. 5 shows the pattern produced by members of a group of five kept together in isolation during 1952-53. Inspection of the figures will show that the detailed resemblances are extraordinarily exact and concern all parts of the song, and the second of these song-types is quite unlike anything that has yet been recorded from the wild.

It appears, then, that the difference between the hand-reared birds and those which had a normal fledgling and early juvenile life, but which were isolated from September onwards, is only explicable on the assumption that some characteristics of the normal song have been learnt in the earliest youth before the bird itself is able to produce any kind of full song. It seems that these birds have by their first September learnt that the song should be in three phrases, and that the terminal phrase should contain a more-or-less elaborate flourish. The details of this terminal phrase with its flourish are apparently not learnt then but are worked out by competitive singing with other members of the group in the following spring.

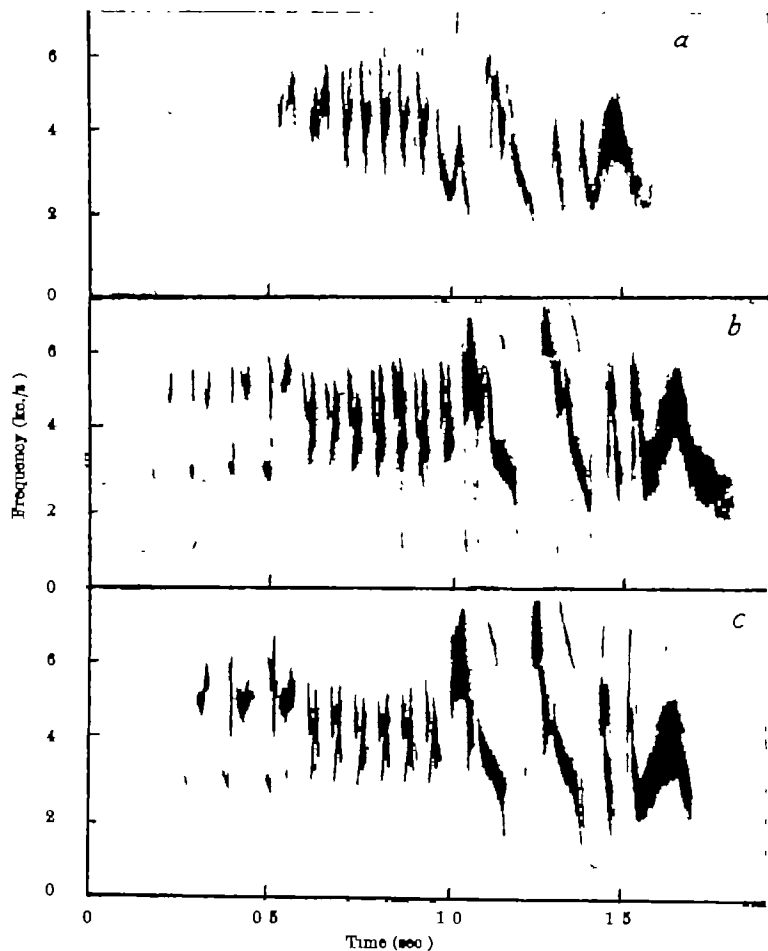


Fig. 2 (a) and (b). Songs of two 1951 chaffinches (*BY/RWB* and *O/GF*) reared by their own parents but isolated as juveniles of five months and allowed only to hear the members of their own group of five birds identically treated during their critical song-learning period in 1952. Note very close resemblance of latter parts of song. (c) Song of *O/GF* in 1953, to show fifty of song in second year even though given opportunity to hear many varieties of chaffinch song in second season. These three songs can be regarded as 'normal'. Scales as in Fig. 1

The experiments with the hand-reared birds suggest that there is an inborn basis to the song but that it is extremely generalized. Innately these birds seem able to produce a song of about the normal length, 2.3 sec., and showing a tendency to *crescendo* accompanied by a fairly steady fall in mean frequency. There is no clear indication of any inborn division of the first part of the song into phrases 1 and 2, but there is a clear tendency in some birds to conclude the song with a single simple note of a higher pitch than the rest. They seem quite unable, by themselves, to produce anything more complex in the way of an ending although, as Fig. 5 shows, they can learn, by a process of mutual stimulation and imitation, to produce precisely controlled and highly elaborate song patterns in what corresponds to phrase 2 of the normal song. (While the present evidence points to the conclusion that these features of the songs produced by hand-reared birds are inborn, we must remember that it has not yet been possible to rear such birds in isolation in the sound-proof room right from the egg. Until this has been done, which we hope will be in the near future, the possibility cannot be ruled out that some details of the song are learnt by the nestling in the first few days after hatching, or even during the last hours in

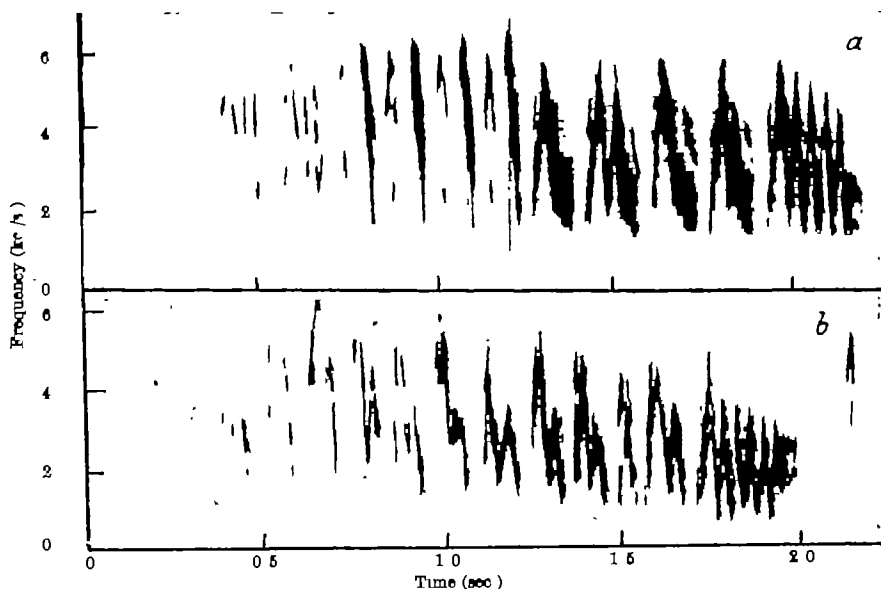


Fig. 3 (a) and (b). Songs of two unrelated 1951 hand-reared chaffinches (*BY/PW* and *RWB/Y*) isolated from about the fourth day of life and during the critical learning period of their first season allowed only to hear each other's songs (Recorded April 1952). Note: Songs abnormal, relatively simple and closely similar. Phrase 3 lacking. Scales as in Fig. 1

the egg. That chaffinches which have been hand-reared can be taught full and elaborate end-phrases when kept during the following spring with older birds selected for their fine songs was known to the German bird fanciers well over a century ago*.)

Study of sound spectrograms makes it clear that it is the pattern of the song that is learnt and not its absolute pitch. One occasionally finds a bird practising a song ending *soho* vocs at a markedly different pitch from that in which it is rendered as part of the full song, and there are other examples of slight change in pitch with changes in intensity of motivation.

Once a song has been acquired and has been sung for a period of a few days at full intensity, it becomes fixed and subsequent changes are extremely slight.

The individual songs of fifteen different birds have now been recorded and analysed in two or more subsequent years, and in nearly every case the differences between the first and second year are so minute as to be practically imperceptible to the naked ear although they will show up on the spectrograph records. Figs. 2b and c show the songs of the same bird in 1952 and 1953. As Fig. 2c shows, a bird in its second year may retain char-

acteristic features in its song which involve a frequency change of a few hundred cycles or less and of only 10–20 msec. duration. Such slight changes that do occur involve small differences of emphasis and occasionally the alteration of a phrase or perhaps the omission of the repeat of a phrase which was doubled in the former year. The sound spectrograph has, however, unexpectedly provided evidence that there is a slight but almost uniform tendency for the song to be shorter, by about 0.1–0.3 sec., in the second year than in the first, and that there is also a slight tendency to increase the frequency-range in all phrases of the song. There is as yet no

clue why this should be so.

It is possible to delay the period of learning a song by keeping the birds together in aviaries under such conditions that they will not sing for the time being, although they see and hear normal birds singing. If such birds are transferred in the summer (that is, July) to a chamber where they are artificially subject first to a gradually decreasing day-length for about eight weeks and then, in early October, to an increasing day-length, their gonad growth will again be stimulated and they will be brought into full song in the autumn (October–November). During this period they show evidence of acquiring the song ending by learning in the same way that they would have done had they been allowed to sing in the spring. Birds can also be brought into song at any

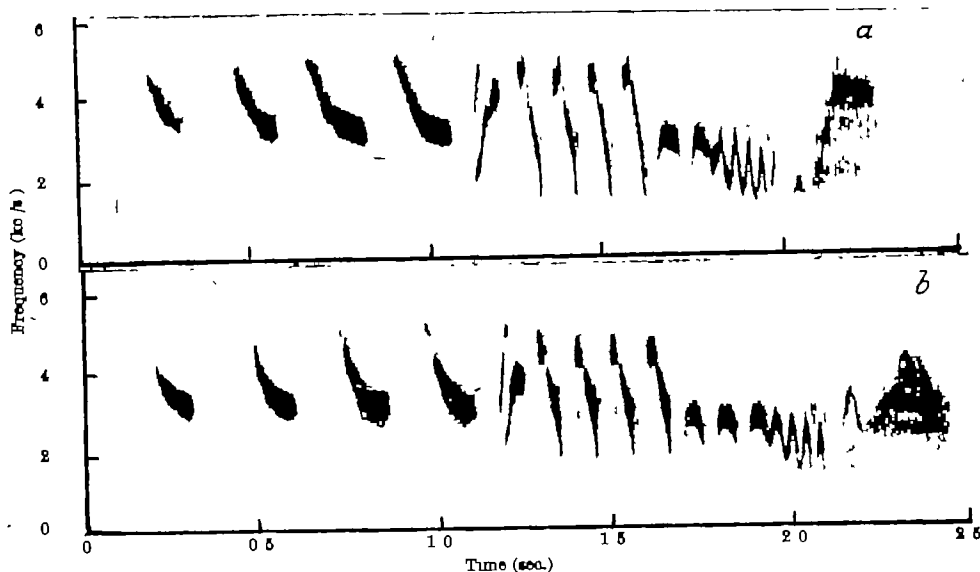


Fig. 4 (a) and (b). Songs of two unrelated hand-reared chaffinches of 1953 (*RWB/W* and *GY/Y*) treated as those shown in Fig. 3. (Recorded June 1953.) Note: Phrases 1 and 2 elaborate but highly abnormal. Phrase 3 extremely simple. The two songs are identical in almost every respect. Scales as in Fig. 1

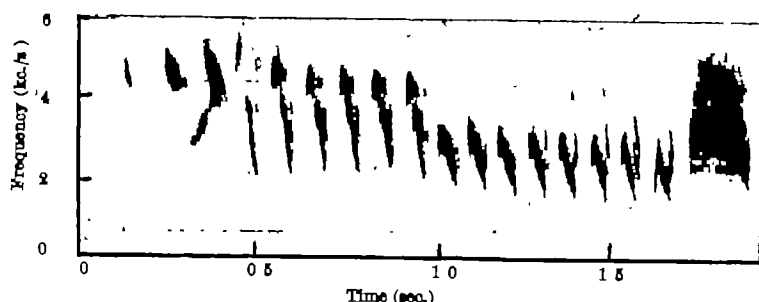


Fig. 5 Song typical of those produced by all members of a group of five 1953 hand-reared chaffinches treated exactly as those shown in Figs. 3 and 4. (SW² recorded June 1953.) Note: Abnormal song with extremely simple phrase 3 (2s. lacking). Scales as in Fig. 1

season of the year by injection with the hormone testosterone propionate. Songs induced by the light method or by hormone injection seem not to differ in any way from the normal.

Bird fanciers rearing these and other finches have long been familiar with the 'sub-song' which precedes the true song in the late winter or early spring. In the chaffinch, this sub-song consists of a long continued and rather irregular warbling which, as the day-length increases and the production of sex hormone (as indicated by the change in colour of the bill) rises, slowly gives place to the phrases of the true song. The process gives to the listener the impression of the true song, so to speak, 'crystallizing out' of the amorphous sub-song. While the sub-song is undoubtedly to some extent a product of the lower degrees of motivation, in that it occurs in the second and later years as well as the first, yet it is much more in evidence in the first and seems to play some part in the process of learning the full song. When studied by the sound spectrograph, the sub-song appears to have a much greater frequency-range than the true song, and one at least of the processes by which the sub-song is transformed into the true song consists of the gradual dropping out of the extreme frequencies which have no place in the latter. The whole matter of sub-song and its differing types and functions in different species is one which requires much more investigation and cannot be dealt with here. Such sub-songs are seldom noticed in the wild because of their low intensity, and also because the bird often sings in very close cover instead of from a conspicuous song post as when producing the true song. Nevertheless, though inconspicuous, the sub-song is, in the chaffinch, a significant feature in the process of song acquisition.

To summarize: We can at present conclude that the normal chaffinch song of three phrases has a very restricted inborn basis amounting to little more than the ability to produce a song of about the normal length (2.3 sec.) and consisting of a *crescendo* series concluded by a single note of relatively high 'pitch'. All further refinements have to be learnt; but the innate basis of the song is probably sufficiently selective to ensure that the bird does not normally acquire notes or songs from any species other than its own. Some learning of details of the first part of the song and also learning of the fact that the song 'should' end in a relatively complex terminal flourish (phrases 3A and B) can take place in the first weeks of life—before, of course, the bird itself is capable of singing. But during this time no details of phrase 3 are acquired. This last phrase, together with more refinement in the early part of the song, is acquired during a period of high learning ability lasting for a period of a few weeks in the bird's first spring, when

it is attempting for the first time to sing in competition with other chaffinches. This results in the development, in isolated groups of hand-reared birds, of distinct community patterns of song; and there is little doubt that the same process of 'imitation' results in the establishment in the wild of the local song 'traditions' which have so long been recognized in this species. There is some evidence that the 'sensitive period' can be delayed for some weeks by experimental treatment, and it sometimes happens

that a bird can at a later stage acquire a second song in addition to its first. The song, once acquired, is retained with little or no alteration in subsequent years. The learning is of a pattern independent of pitch, though the birds are able to maintain a constant pitch with great accuracy. Some references on the sound spectrograph are appended¹⁻³.

¹ Ward, Thomas, "The Bird Fancier's Delight" (1714).

² Thorpe, W. H., *Ibis*, 93, 1 and 252 (1951).

³ Marler, P., *Ibis*, 94, 458 (1952).

⁴ See Poulsen, H., *Behaviour*, 8, 216 (1951).

⁵ Falconer, D. S., *Brit. Birds*, 25, 98 (1941).

⁶ Bechstein, J. M., "Naturgeschichte der Stubenvögel" (1795).

⁷ Potter, B. K., *Science*, 103, 463 (1945).

⁸ Koenig, W., Dunn, H. K., and Lacy, L. Y., *J. Acoust. Soc. Amer.*, 18, 19 (1946).

⁹ Joss, M., *Language*, 24, No. 2, supp. (Language Monograph No. 23, "Acoustic Phonetics"; 1948).

EXCITED NUCLEONS

By PROF. C. F. POWELL, F.R.S.

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DURING the past year, evidence has gradually accumulated for the existence of a new type of nuclear excitation which appears to be due to the presence, within a nucleus, of a neutral hyperon*, now designated Λ^0 . It is believed that this particle can be bound to the other nucleons of a nucleus to form a relatively stable structure as measured on a nuclear time-scale, and that the eventual disintegration of such a nucleus is due to the decay of the Λ^0 -particle.

The existence of the Λ^0 -particle, which until recently was referred to as the 'heavy neutral V -particle', was established by experiments on the cosmic radiation with Wilson chambers. It was shown to be the more common of the neutral particles which produce the 'neutral V -events' discovered by Rochester and Butler¹ in 1947. Most of these events are now known to be due to two types of particles: (i) Λ^0 , which decays into a proton and a negative π -meson: $\Lambda^0 \rightarrow P + \pi^-$, with a release of energy between 35 and 40 MeV.^{2,3}; and (ii), θ^0 , a heavy neutral meson which transforms into two light mesons, probably π -particles: $\theta^0 \rightarrow \pi^+ + \pi^-$, with an energy release of approximately 210 MeV.^{2,4}. The mean life-times of the two types are approximately $t_{\Lambda^0} \sim 3 \times 10^{-10}$ s., and $t_{\theta^0} \sim 2 \times 10^{-12}$ s., respectively⁵.

It is now known that the Λ^0 -particle can be produced in nuclear interactions in which the available kinetic energy is insufficient to provide all the rest-

* The nomenclature employed is that recently proposed by Amaldi *et al.* (*Nature*, 173, 123; 1954). A hyperon is a particle with mass between that of the neutron and that of the deuteron.

mass of the particle^{6,7}. It is therefore believed that it results from a modification of a nucleon as a result of the collision. This fact, and the observation that in its decay it is transformed into a proton, suggests that it may be useful to regard it as an 'excited' nucleon. An excited atom can return to its normal state of energy by emitting a quantum of radiation, a photon; by analogy, an excited nucleon is conceived to relax by emitting a 'heavy quantum' of the nuclear field, that is, a π -meson.

It has recently been found possible to make very accurate measurements of the mass of the Λ^0 -particle by the photographic method. In a stack of stripped emulsions, exposed at high altitude, Friedlander, Keefe, Menon and Merlin⁸ in Bristol have found eight examples of tracks due to the decay of Λ^0 -particles in each of which both the secondary proton and the negative π -meson are arrested in the stack. The ranges of the two particles can thus be measured, and thence their energies. These observations, and the angle of inclination with which the two particles are ejected, permit an accurate evaluation of the energy release, Q . The mean result thus obtained is 37.2 ± 0.5 MeV. in satisfactory agreement with the cloud-chamber observations. The corresponding value of the mass of the Λ^0 -particle is $2,182 \pm 2 m_p$. The quoted errors in the energy release are those deduced from the inner consistency of the measurements. The final value may have to be amended when a more accurate range-energy relation for protons has been established.

The original discovery suggesting that hyperons can exist not only as free particles but also bound within nuclei was due to Danyasz and Pniewski⁹. They observed a heavy nuclear fragment, of charge $\sim 5e$, emitted from a nuclear disintegration recorded in a photographic plate exposed to the cosmic radiation. The particle appeared to reach the end of its range, where it disintegrated with the emission of three or four charged particles.

The striking feature of the observation was that the disintegration occurred at the end of the range, when the parent particle was at rest, or moving with very low velocity. The secondary disintegration could not therefore be due to a collision of the fragment with another nucleus. Instead, it was attributed to the spontaneous disintegration of the fragment. This view, however, had to meet the following difficulty. When a nucleus is struck by a nuclear particle, such as a proton, large amounts of energy can be conveyed to it so that it becomes violently excited. We picture the nucleons as being put into a state of violent motion, a motion of 'thermal agitation', as a result of which the nucleus disintegrates, several of its nucleons being 'evaporated'. The time for such a process is believed to be of the order of 10^{-14} s. In the case of the fragment observed by Danyasz and Pniewski, however, its time of flight, from the instant of its ejection to the moment of arrest at the end of its trajectory, was $\sim 3 \times 10^{-12}$ s. The particle, therefore, survived at least several million times longer, before disintegrating, than would be expected according to our conventional picture of nuclear excitation.

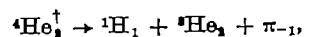
In order to resolve this difficulty, Danyasz and Pniewski suggested that the observed effects were due to the presence, among the nucleons of the fragment, of a hyperon—an excited nucleon. The observed disintegration was then associated with the decay of the hyperon. Alternatively, they suggested that the fragment might have emerged from the

parent disintegration with a meson moving around it in a bound orbit. The disintegration of the fragment was then to be attributed to the capture of the meson, and the liberation, among the nucleons, of the energy corresponding to the rest-mass of the meson. Such disintegrations due to nuclear capture of free π -mesons arrested in photographic emulsions are commonly observed in plates exposed to cosmic radiation.

Very shortly after the first observation, a second similar example, involving an ejected nuclear fragment of charge 2 or 3, was found by Tidman *et al.*¹⁰. This observation was important because it appeared to eliminate the possibility, certainly very remote, that the original event was due to the chance occurrence, precisely at the end of the track of the nuclear fragment, of a small unrelated disintegration.

Some months later, two further similar events were discovered by Crusard and Morellet¹¹ and by Frauer¹², which appeared to exclude the possibility that the phenomenon was to be attributed to a π -meson in a bound orbit. In each of the new events, a small disintegration with three secondary charged particles occurred at the end of the range of an ejected nuclear fragment of small charge, and one of the secondary particles could be proved to be a π -meson. Such an observation cannot be interpreted in terms of the nuclear capture of a π -meson, as this would provide insufficient energy to account for the disintegration. This difficulty could be avoided if the captured meson were assumed to be of greater mass—a χ -meson, for example. In both the new events, however, the release of kinetic energy appeared to be of the order of 40 MeV., a value consistent with the original assumption of the presence of a Λ^0 -particle among the nucleons of the ejected fragment. Very strong evidence for the correctness of this view has now been provided by two further examples which, because of the simplicity of the nuclear systems involved, allow a very precise analysis.

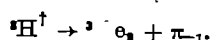
In the example described by Hill *et al.*¹³, the ejected particle is probably a nucleus of mass number 4, charge 2. At the end of its range it appears to disintegrate into a π -meson and two other charged particles. If the transformation is represented:



there is a momentum balance among the secondary charged particles, and the release of energy is ~ 33.8 MeV. A detailed analysis, using the accurate value for m_{Λ^0} , shows that, if the above interpretation is correct, and if the original fragment contains a Λ^0 -particle within it, the binding energy of the latter is ~ 4 MeV. This value may be compared with the energy required to remove a neutron from an α -particle, namely, ~ 20 MeV.

An event recently described by Bonetti *et al.*¹⁴ allows an even more detailed analysis. The mass of the ejected fragment, of charge 6, can be determined, and the value found is $\sim 5,500 m_p$ —approximately the mass of the triton. At the end of its range, the particle disintegrates into two charged particles which recoil in opposite directions, so that the two tracks are collinear. One of the secondary particles is a π -meson of great range which, on stopping in the stack, is captured by a nucleus and disintegrates it. The other produces a short recoil track. If this particle is assumed to be a nucleus of helium-3, as appears to be demanded by the need to conserve

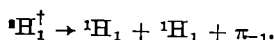
mass-number and charge, its momentum, as deduced from its range, is found to equal that of the π -meson. The transformation may therefore be written:



The total release of energy is 41.5 MeV., a value which corresponds to a binding energy of the Λ^0 -particle to the other two nucleons of the excited triton equal to about 1.5 MeV.

The latest two events, which allow such a close analysis, appear finally to exclude the possibility that the phenomenon under discussion is to be explained in terms of a meson in an orbit around the nucleus. Such an explanation, in the case of a light meson (π), has already been eliminated by the observed emission of π -mesons from the disintegrating fragment; but the possibility of a heavy meson remained. In the last two events, however, there is a momentum balance among the charged secondary particles, and the total release of kinetic energy is about 40 MeV. If the disintegrations are attributed to the nuclear capture of a negative heavy meson, an energy of ~ 300 MeV. remains unaccounted for. The emission of a neutral particle, or particles, of high energy and momentum, would therefore have to be assumed. The observed momentum balance, so convincingly demonstrated in the event described by Bonetti *et al.*—together with the values of the binding energy of the Λ^0 -particle deduced on the basis of the alternative assumption—would then have to be regarded as fortuitous. Such a possibility is remote and can be rejected on the grounds of its extreme improbability. It appears, therefore, that the explanation in terms of a Λ^0 -particle is alone acceptable.

In view of the many laboratories now working on the subject, it seems certain that many further examples permitting a detailed analysis will soon be found. In time, it should be possible to determine the binding energies of the Λ^0 -particle in a variety of nuclear species. It has been pointed out by Cheston and Primakoff¹² that a particularly interesting example, not hitherto observed, would be an excited deuteron:



It remains to be seen, however, whether the cohesion between a Λ^0 -particle and a single proton is strong enough to render such an assembly sufficiently stable to be observed.

It has been suggested in an earlier paragraph that it may be useful to describe the Λ^0 -particle as an excited nucleon, but it is already clear that the analogy is of limited validity. An excited hydrogen atom, to use the simplest example, consists of a proton and an electron in a state of higher energy than in the normal atom. The analogy might then suggest that the excited nucleon consists of a proton and an associated π -meson—that the Λ^0 is a composite particle. Such a view could not have been finally excluded while our knowledge was confined to the decay of the free Λ^0 -particles. Their relative stability as components of nuclei appears, however, to do so, for it is generally believed that, when captured by a nucleus, a π -meson interacts with its nucleons in a time short compared with 10^{-13} s., the disappearance of its rest-mass providing the energy of the disintegration. In the event described by Bonetti *et al.*, however, the nuclear fragment per-

sisted for longer than 2×10^{-10} s. before disintegrating. If the Λ^0 -particle consisted of a π -meson bound to a proton, it is difficult to see how the nuclear fragment could persist for such a long time on a nuclear time-scale. One would expect the bound π -meson to disintegrate the nucleus just as it does when captured from outside.

These considerations suggest that the Λ^0 -particle is an excited nucleon in a different sense from that suggested by familiar analogies. We are entering a new field where basically new concepts remain to be established; but it seems reasonable to conjecture that the nucleon is transformed into an excited nucleon as a result of changes in its internal constitution. If so, we are beginning to make a new penetration into what Maxwell called "the strange strata of the material world", a penetration into the world of the nucleon. It seems that matter is inexhaustible.

¹ Rochester and Butler, *Nature*, 160, 855 (1947).

² See discussion, Bagnères Conf. Report (1953).

³ Barker, *Proc. Roy. Soc., A*, 211, 328 (1954).

⁴ Thompson, Bueckert, Cohn, Karmark and Redfick, Bagnères Conf. Report, p. 30 (1953).

⁵ See discussion, Bagnères Conf. Report (1953).

⁶ Froster, Gregory, Johnston, Lagarrigue, Meyer, Müller and Peyrou, Bagnères Conf. Report, p. 25 (1953).

⁷ Fowler, Shink, Thorndike and Whitmore, *Phys. Rev.* (in the press).

⁸ Friedlander, Keefe, Menon and Merdin, *Phil. Mag.* (in the press).

⁹ Danysz and Pniewski, *Phil. Mag.*, 44, 348 (1953).

¹⁰ Tidman, Davis, Hees and Tennant, *Phil. Mag.*, 44, 350 (1953).

¹¹ Crussard and Morellet, *O.R. Acad. Sci., Paris*, 233, 64 (1953).

¹² Froster, reported by Ney, Bagnères Conference, mimeographed report, p. 253 (1953).

¹³ Hill, Balant, Widgoff, Osborne, Pevener, Risson, Crussard and Walker, *Bull. Amer. Phys. Soc.*, 29, 60 (1954).

¹⁴ Bonetti, Levi, Sott, Panetti, Sordani and Tomassini, *Nuovo Cimento*, 11, 210 (1954); and private communication.

¹⁵ Cheston and Primakoff, *Phys. Rev.*, 92, 1557 (1953).

OBITUARIES

Mr. Albert Campbell

ALBERT CAMPBELL, who died in Cambridge on February 6 at the age of ninety-one, will long be remembered as a pioneer in electrical science, especially in the fields of alternating current measurements and standards. He was one of the small band of men who under Glazebrook's leadership built up the National Physical Laboratory from almost nothing in 1901 to the research laboratory with a world-wide reputation that it had already become when Glazebrook retired in 1919. Campbell himself retired a little before Glazebrook, though not for the same reason; he had not reached the customary retiring age, but he realized that conditions were changing. To be a leading member of a research team in a government laboratory was a very different prospect from being a pioneer opening up new ground with freedom to move in whatever direction the spirit prompted. He retired and continued to work at home with home-made instruments, until, with a failing memory, he found himself no longer able to do scientific work.

The main body of Campbell's work was, of course, done at the National Physical Laboratory between 1901 and 1919, the most important single item being his primary standard of mutual inductance, constructed in 1907 and still the ultimate reference standard for nearly all the measurements of inductance, capacitance and related quantities made in

Great Britain. The work he did after his official retirement was, however, no less remarkable. It included his alternating-current potentiometer, which in some respects has not been surpassed, and also his best method for the absolute determination of the ohm. Has any other man three absolute methods to his credit? Naturally enough, with home-made instruments his accuracy was limited to barely 1 part in 10,000, but when elaborated at the National Physical Laboratory his method proved to rank with the best known to-day.

It is scarcely possible to indicate the scope of his work in a short note, but it is worth recalling that he devised the inductometer (his name for a continuously adjustable and direct-reading standard of inductance), the constant-inductance rheostat, the vibration galvanometer, the 'waveform sifter', one of the earliest electrical filters and the forerunner of the modern twin-T bridges. He set up the first standard wavemeter at the National Physical Laboratory, calibrated it absolutely by counting flashes in an oscillatory arc, and showed that the result agreed with values calculated from his measurements of inductance and capacitance. He also devised many alternating current bridges and methods for measuring all the magnetic properties of importance to the electrical industry.

Campbell's strong practical bent is the more remarkable in that at Cambridge he first read for the Mathematical Tripos, from which he went on to the natural sciences. In 1893 Alexander Russell persuaded him to go to Faraday House, London, where he remained until he joined Glazebrook. It was no doubt there that he acquired his insight into the scientific needs of the rapidly growing electrical industry, which he served so well in his own inimitable way later.

It is remarkable that, with one notable exception, none of the scientific honours that it is customary to shower on a man of his distinction seems to have come his way. He was a man of singular personal charm who showed the same interest in all his fellow-workers from the boy in the workshop to the clerk in the office and the most eminent scientific man of his time. One of these last once remarked of him that "Nobody had a kinder heart or a sharper tongue", from which it may be inferred that he was sometimes a thorn in the flesh of the authorities. In 1925 the Physical Society awarded him the Duddell Medal; and never was that honour more appropriately bestowed or more richly deserved.

L. HARTSHORN

Prof. D. S. Belyankin

WITH the death of Dmitry Stepanovich Belyankin, the U.S.S.R. has lost one of their most prominent petrologists. He was born on August 28, 1876, in Lomanikha, Vologda district, and died on June 20, 1953, in Moscow. Trained as a chemist under G. Tammann in the University of Yuriev (Dorpat), he occupied successfully the posts of lecturer and of professor of mineralogy and petrology in the St. Petersburg Polytechnic Institute.

After his election as corresponding member of the Academy of Sciences in 1938, he became a member of the Petrographical Institute of the Academy, and moved to Moscow in 1935. In 1943 he was elected a full member of the Academy and after that he occupied a number of its more important posts, being

director of the Petrographical Institute and the Mineralogical Museum, editor of the Geological Section of the Bulletin and co-editor of the *Compte Rendu (Doklady)* of the Academy.

Belyankin published some three hundred and eighty papers and books (many of them written in collaboration), dealing with mineralogy, regional and descriptive petrology and technical petrology. He was particularly interested in feldspars, clay minerals and other silicates, and described and named several new species. He described various igneous rocks from Northern Russia, the Ural Mountains and the Caucasus, and wrote papers on magmatic differentiation and the nomenclature of igneous rocks. He was particularly interested in the development of technical petrology, of which he was the acknowledged master. He created the Russian school in this subject and he and his collaborators contributed a large number of works dealing with the study of refractories, ceramic products, glasses and metallurgical slags.

Belyankin combined an all-absorbing devotion to science with a friendly disposition towards all his pupils and friends, among whom I was proud to be included.

S. I. TOMCHIKOFF

Prof. Giorgio Valle

ITALIAN science has suffered a grievous loss by the sudden death last December of G. Valle, head of the Department of Physics and director of the Righi Institute of the University of Bologna. Valle, who was born on December 15, 1888, at Trieste, read physics at the University of Vienna, where, having taken the degree of Dr. Phil., he worked as a demonstrator under E. Lecher until 1914. After the First World War, Valle taught for a short time at the Technical School at Terni and was later appointed professor at the Technical Institute at Bologna. In 1922 he moved to Asti, where he taught science at the Classical High School, at the same time lecturing to advanced students at the University of Turin. In 1932 he was appointed professor of experimental physics at the University of Ferrara, and in 1938 to the chair of physics at Parma, which he held until 1947. In that year he was elected to the chair of physics at Bologna, a post formerly held by A. Righi and Q. Majorana.

Valle, an assiduous worker, published more than seventy papers, mostly in *Nuovo Cimento*, the proceedings of the Accademia dei Lincei and of the Accademia di Torino, the *Wiener Berichte* and the *Physikalische Zeitschrift*. He made a series of notable contributions in the field of electric discharges, also in magnetism, acoustics, physical optics and meteorology. He was author or co-author of several text-books as well as of a volume of extracts from Righi's papers (see *Nature*, 167, 174; 1951) which he published in collaboration with G. C. Dalla Nave.

Valle was a man of great energy and vitality, and although during the past few years handicapped by the loss of his voice, he continued his scientific work until a month before his death. At the Righi Centenary Celebrations at Bologna in 1950, Valle, as an officer of the Italian Physical Society, was host to scientists from many countries, including Great Britain. A few months before his death he was at last able to gratify his wish to visit England, where he took part in the Oxford conference on ionization phenomena.

A. VON ENGEL

NEWS and VIEWS

Scientific Adviser's Branch, Home Office :

Sir Edward Paris, C.B.

SIR EDWARD PARIS, who has recently retired from the position of chief scientific adviser to the Home Office, received his early scientific training at the Imperial College of Science and Technology and at University College, London, where he worked with Prof. A. W. Porter on the polarization of light. During the First World War he saw service in a Sound-Ranging Section in France. He there came into contact with Major W. S. Tucker, and, after the War, Tucker and Paris collaborated first at the Munitions Inventions Department and afterwards at the Signals Experimental Establishment, Woolwich, in their investigation of the use of the hot-wire microphone for sound detection. Between the two Wars, Paris worked as an experimental officer in the Air Defence Experimental Establishment until, in 1938, he was appointed deputy director of scientific research at the War Office under Dr. H. J. Gough. A year later the scientific branches were transferred to the Ministry of Supply, and it was there, under the stress of war, that Paris showed great qualities as a scientific administrator. Like others in senior posts in that Ministry at the time, he went through a bewildering succession of changes of designation, denoted by ever more complicated initials; but he remained unperturbed and unperturbable, and the work went on. In 1946 he was principal director of scientific research (defence). He was created C.B. in 1947. In 1948 he was appointed to the Home Office, and there, as chief scientific adviser, he has been conspicuously successful in directing the research and advising on the scientific problems arising in the civil defence planning in Britain for which the Department is responsible. The conferment of a knighthood on him, announced in the New Year Honours, has given great pleasure to his friends and colleagues.

Dr. R. H. Purcell

DR. R. H. PURCELL, who has been appointed to the post of scientific adviser to the Home Office in succession to Sir Edward Paris, took a degree in chemistry at the Royal College of Science in 1924. After conducting research under Prof. H. B. Baker, he was elected to a Ramsay Memorial Fellowship which he held at Amsterdam and the Royal College of Science. He later became lecturer in physical chemistry in the Royal College of Science. He joined the scientific staff of the Admiralty during the War, and was occupied on a number of scientific inquiries which were of urgent practical importance. In 1947 Dr. Purcell was promoted to the rank of senior principal scientific officer for special scientific merit, and has only recently been made a deputy chief scientific officer in the Royal Naval Scientific Service. Since the War Dr. Purcell has been directly concerned with the naval aspects of defence against atomic weapons, and these experiences will be important to him in his new duties.

Canning Section of the Low Temperature Research Station, Cambridge :

Mr. T. N. Morris

MR. THOMAS NORMAN MORRIS, who retired at the beginning of this year from his post as head of the Canning Section of the Low Temperature Research Station, Cambridge, was born in 1889 at Haddenham,

Isle of Ely (Cambs), of local farming stock on both sides, and was educated in Cambridge at the County School for Boys and then at the University, being a scholar of St. John's College. After Part 1 of the Natural Sciences Tripos, in which his subjects were botany, chemistry, zoology and physiology, he read for the Agricultural Diploma and then in 1911 took botany in Part 2 of the Tripos. During the First World War he was bacteriologist for acetone production in H.M. Factory at King's Lynn and was later employed by the Ministry of Munitions on the production of picric acid as chemist in charge of the laboratory at Halifax, Yorks. After the War he was research chemist with the firm of Chivers and Sons, Ltd., Histon, Cambs, until in 1927 Sir William Hardy appointed him to be head of the Canning Section of the Low Temperature Research Station. Work in this Section was initially concerned with corrosion problems relating to tin-plate cans, but was later extended to include the freezing of fruits and vegetables, the concentration of fruit juices, the dehydration of foods and the behaviour of pectin in fruits during storage and processing, particularly in relation to the manufacture of jams and jellies. Apart from his scientific occupations, Mr. Morris's main interest is practical farming, and now that he has retired he intends to apply his scientific and agricultural knowledge to this end.

Prof. Otto Hahn

To mark the anniversary of his seventy-fifth birthday on March 8, Prof. Otto Hahn, the nuclear physicist, was awarded the Grand Cross, Second Class, of the Order of Merit of the Western German Federal Republic. He was invested with the insignia of the Order at the offices of the Max Planck Society, of which he is president; and on the same occasion he was awarded the Harnack Medal of the Society.

Napier Shaw Memorial Prize of the Royal Meteorological Society

MARCH 4 marked the centenary of the birth of Sir Napier Shaw, whose life extended into its tenth decade, spanning an era of scientific as of political revolution. Sir Napier's remarkable career can be divided into three main phases. As Fellow and senior tutor of Emmanuel College, Cambridge, he established a reputation as a successful university teacher of physics, an occupation which he abandoned only at the turn of the century to become director of the Meteorological Office, and president of the International Meteorological Organization, in which capacities he probably did more than any other man of his time to promote the subject by encouraging new observational methods, a scientific treatment of data, and meteorological research generally. Finally, at the age of sixty-six, he became the first professor of meteorology at the Imperial College of Science and Technology, London, and there laid the foundation of formal training in the subject.

As a result of an appeal to the members of the Royal Meteorological Society and to scientific instrument manufacturers, a memorial fund has been raised by the Society to commemorate the unique position which Shaw achieved in British meteorology. It has been decided to use this fund for the regular award by competition of a Napier Shaw Memorial Prize. The competition will be open to anyone without restriction of nationality. The prize of £100 is offered on this occasion for an original essay on "The Energetics of the General Circulation". The

essay will be expected to treat of the energy transformations of the circulation as a general theme or any particular aspects of that theme. It may be an essay in which the author describes and discusses the salient and essential features of the general circulation and the energy transformations involved; it may be an essay which attempts an adequate synopsis and discussion of the observations, or a study of the thermodynamics and hydrodynamics of the circulation; or the essay may treat of any combination of these within the general theme. The essay, which must be in English, may include material which the candidate has already published. Essays may be submitted jointly in the names of more than one author. All entries must be addressed to the Assistant Secretary, Royal Meteorological Society, 49 Cromwell Road, London, S.W.7, and marked clearly 'Napier Shaw Prize', and should be received at the Society's Offices not later than March 4, 1956.

Royal Society of Edinburgh: New Fellows

THE following have been elected Fellows of the Royal Society of Edinburgh: Dr. H. M. Adam, senior lecturer in pharmacology, University of Edinburgh; Mr. J. K. Allan, chief geologist, National Coal Board, London; Mr. B. L. Burt, principal scientific officer, Royal Botanic Garden, Edinburgh; Dr. Enid Charles, reader in demography and vital statistics, University of Birmingham; Dr. E. F. Collingwood, Lilburn Tower, Northumberland; Dr. I. MacP. Dawson, senior lecturer in electron microscopy, University of Glasgow; Dr. J. Duckworth, Rowett Research Institute, Bucksburn; Mr. W. G. Emmett, reader in experimental education, University of Edinburgh; Dr. C. E. Foister, chief plant pathologist, Department of Agriculture for Scotland; Mr. H. D. Griffith, lecturer in natural philosophy (medical physics), University of Aberdeen; Prof. G. Hibberd, Dixon professor of mining, University of Glasgow; Prof. N. Kemmer, Tait professor of natural philosophy, University of Edinburgh; Mr. T. Lawrie, general manager, North of Scotland Hydro-Electric Board; Prof. R. D. Lockhart, professor of anatomy, University of Aberdeen; Dr. C. Long, senior lecturer, Department of Biological Chemistry, University of Aberdeen; Dr. D. K. O. MacDonald, director, Cryogenic Laboratory, Division of Physics, National Research Council, Canada; Miss Agnes E. Miller, lecturer in zoology, University of Glasgow; Prof. D. C. Mack, professor of mathematics, Royal Technical College, Glasgow; Dr. Mary Pickford, reader in physiology, University of Edinburgh; Dr. B. Raistrick, research manager, Scottish Agricultural Industries, Ltd.; Prof. G. S. Rushbrooke, professor of theoretical physics, King's College (University of Durham), Newcastle upon Tyne; Mr. G. I. Scott, consultant ophthalmologist, Edinburgh; Dr. N. B. Slater, lecturer in applied mathematics, University of Leeds; Dr. R. B. Strathdee, reader in chemistry, University of Aberdeen; Mr. J. Wallace, head of the Science Department, Melville College, Edinburgh.

Research Into Rain-making

REPLYING in an adjournment debate in the House of Commons on February 23 to Mr. G. de Freitas's request for increased research into weather modification, the Under-Secretary of State for Air said that the Meteorological Office is studying reports of rain-making activities all over the world; but he was advised that available scientific evidence on the

practical side is not entirely convincing. Since the Advisory Council on Scientific Policy expressed the opinion in 1951 that no expenditure of effort on large-scale field trials was called for without further research, the Meteorological Office has carried out research on cloud rainfall problems, and practical experiments have been made by the Meteorological Research Flight of the Royal Air Force, more with the object of increasing knowledge than of trying to produce rain. Rain-making, and the present state of our knowledge of the subject, will shortly come before the Physical Sub-Committee of the Meteorological Research Committee, which advises the Secretary of State for Air on this subject, and the future course of action will then be reconsidered.

National Institute of Sciences of India: Council and New Fellows

THE Council of the National Institute of Sciences of India has been elected for 1954 as follows: *President*, Sir K. S. Krishnan; *Vice-Presidents*, Prof. S. K. Banerji and Dr. B. Mukerji; *Treasurer*, Prof. D. S. Kothari; *Foreign Secretary*, Prof. P. C. Mahalanobis; *Secretaries*, Prof. R. C. Majumdar and Dr. B. P. Pal; *Editor of Publications*, Prof. J. M. Sen; *Members of Council*, Prof. S. P. Agharkar, Prof. K. N. Bagchi, Dr. J. L. Bhaduri, Dr. Verrier Elwin, Prof. P. S. Gill, Prof. A. C. Joshi, Dr. V. R. Khanolkar, Dr. M. S. Krishnan, Dr. D. R. Malhotra, Prof. S. K. Mitra, Dr. M. A. Moghe, Dr. H. S. Pruthi, Prof. B. Sanjiva Rao, Dr. V. Subrahmanyam, Prof. N. R. Tawde, Mr. M. S. Thacker and Dr. A. O. Ukil; *Representative of the Government of India*, Dr. D. N. Wadia; *Representatives of the Asiatic Society*, Prof. H. K. Mookerjee and Dr. U. P. Basu; *Representatives of the National Academy of Sciences*, Prof. Shri Ranjan and Dr. R. K. Saksena; *Representatives of the Indian Science Congress Association*, Dr. S. L. Hora and Dr. B. N. Prasad; *Ex-Officio Members (Past Presidents)*, Dr. Baim Prashad, Dr. J. O. Ghosh, Dr. D. N. Wadia, Sir S. S. Bhatnagar, Prof. S. N. Bose and Dr. S. L. Hora.

The following elections have also been made to fellowships of the Institute. *Honorary Fellows*: Prof. Sydney Chapman, recently Sedleian professor of natural philosophy, University of Oxford; Prof. V. A. Engelhardt, Soviet Academy of Sciences, Moscow; Prof. W. Heisenberg, director of the Max Planck Institute, Göttingen; and Prof. Paul Karrer, director of the Chemistry Institute, University of Zurich. *Ordinary Fellows*: Dr. B. C. Basu, research officer in entomology, Indian Veterinary Research Institute, Izatnagar; Dr. S. K. Bhattacharya, assistant professor of chemistry, Institute of Technology, Kharagpur; Prof. K. Chandrasekharan, professor of mathematics, Tata Institute of Fundamental Research, Bombay; Prof. K. R. Dixit, professor of physics, Institute of Science, Bombay; Dr. S. Ghosh, professor of chemistry, University of Allahabad; Dr. A. G. Jhingran, superintending geologist, Geological Survey of India, Calcutta; Prof. S. Kilpady, professor of geology, University of Nagpur; Dr. Z. R. Kothavala, director, Dairy Research, Government of India, Bangalore; Dr. L. S. S. Kumar, principal, College of Agriculture, Pona; Dr. N. V. Modak, special engineer, Bombay Municipality; Prof. C. Radhakrishna Rao, professor, Indian Statistical Institute, Calcutta; Mr. A. K. Roy, officiating deputy director-general of observatories, Meteorological Office, New Delhi; Dr. R. N. Sen, lecturer in mathematics, University of Calcutta;

Mr. M. R. Sen Gupta, principal of the Engineering College, Banaras Hindu University; and Dr. S. M. Sircar, lecturer in botany, University of Calcutta.

Vitaminization of Margarine

ALTHOUGH skim milk has a high nutritional value, it is not a popular article of diet and, consequently, the separation of milk fat for use as cream or butter results in a considerable wastage of the valuable proteins, minerals and water-soluble vitamins. There can be little doubt that nutritional economy demands the use of milk as whole milk, not separated into different fractions. In communities where butter has become a regular item in the diet, it then becomes necessary to find a butter substitute, chiefly as a 'spreader' for bread. Almost any hardened edible oil would do for this purpose; but in order to safeguard the health of those who will not take enough milk to yield the amount of milk fat they would otherwise have taken as butter, it is important that butter substitutes should be reinforced with the fat-soluble vitamins A and D to approximately the same levels as are normally found in butter. A high proportion of margarine of domestic quality in Britain was already being reinforced in this way in 1939; but it was only during the War that it became a statutory condition of licence to manufacture that these two vitamins should be added in prescribed quantities. Now that margarine is due shortly to be decontrolled, the Food Standards Committee of the Ministry of Food has recommended that all home-produced and imported domestic margarine should be required to reach the following levels: vitamin A, 760-940 international units/oz.; and vitamin D, 80-100 international units/oz. The recommended level for vitamin D is approximately the same as that at present prevailing; that for vitamin A is somewhat higher, the present level being 450-550 international units/oz. The report has been issued by the Ministry of Food.

Limits for Zinc in Foods

ALTHOUGH zinc is a normal constituent of the human body and its presence in the enzyme carbonic anhydrase suggests that it may be an essential element in the diet, nevertheless far more importance is attached to the necessity of avoiding an excessive intake than of ensuring an adequate one. The Food Standards Committee (Metallic Contamination Subcommittee) of the Ministry of Food in a report, in a recent publication issued by the Ministry, recommends that the following limits should be observed: beverages which are ready to drink, 5 p.p.m.; and other foods, 50 p.p.m. But it adds that "in view of the high natural zinc content of certain animal and vegetable products, e.g. herrings, shell-fish, and crustacea, cereal offals and animal offals . . . no objection should be taken to the sale of such articles containing zinc in excess of 50 p.p.m. if it can be shown that the zinc is of natural occurrence". A maximum limit of 100 p.p.m. is already prescribed for edible gelatin and, apart from this, the Committee does not consider it necessary that statutory effect need be given to the limits recommended. It would appear that risk of zinc poisoning comes almost entirely from the use of zinc or galvanized iron equipment in kitchens and food stores. Such equipment is corroded not only by acid foods (for example, apples) but also by salt solutions, so that it is generally unsuitable for any cooking or food-storage purposes. The Committee also directs

attention to the fact that "outbreaks of poisoning have been attributed to the inadvertent use of galvanized vessels, for example, to drinking rain water collected from galvanized iron roofs or stored in galvanized iron tanks". The main symptom of zinc poisoning is an outbreak of violent vomiting.

The Earth's Shadow

AN article in *l'Astronomie* (November 1953), entitled "Sur l'Ombre de la Terre", by J. Dubois, of the Bordeaux Observatory, gives the results of some recent research, and more especially of his own work carried out at the Pic-du-Midi Observatory and at Bordeaux, on the phenomenon of the earth's shadow or the anticrepuscular arch. This phenomenon, which occurs a short time before sunrise and a short time after sunset, is briefly described for sunset; but the same description in inverse chronological order applies also at sunrise. As soon as the apparent altitude of the sun is less than about 2° , a greyish-blue zone rises above the eastern horizon, slowly ascending as the sun sinks, changing in colour from blue to an increasing dark hue, and ending as a vast surbased arc, forming what is known as "the earth's shadow". Some minutes after sunset a whitish zone, somewhat bright, called "Albe" by M. Durand-Greville, is clearly distinguished, and to it is due the re-illumination of clouds or of the tops of mountains—phenomena which have puzzled many observers and for which various theories have been proposed. In a discussion of the history of the observations and aim of the researches, reference is made by M. Dubois to the observations of Gruner and R. P. Combiar, the latter having published the results of his work during the years 1938-40. However, it is to M. Dubois that the most important work is due, and all who are interested in the phenomenon would be well advised to read the description of his equipment and his conclusions. In this short note, attention can merely be directed to a few of his deductions, from the time when he started work in 1945 until he completed it four years later. He points out that the conclusions deduced by observations with the spectrophotometer are consistent with his theories, and that the main factor in promoting the anticrepuscular arch is the ozone in the atmosphere localized between heights of 20 and 30 km. The blue tint observed must be attributed to the feeble intensity of the yellow and red radiations which are rather strongly absorbed by the ozone. It appears that absorption by aqueous vapour and oxygen has very little effect on the intensity and colour of the arch.

Blundell's School Science Society

THE recent edition of the *Magazine of the Blundell's School Science Society* (No. 8, 1952-53) reveals a year of considerable activity which continues to reflect exceptional credit on the School's activities, especially in biological field work. This practical work carried out by the boys is obviously well organized, for the papers published show the real research spirit. The School has now started a colony of bees, and a tank of sticklebacks is being kept not merely for amusement but also for behaviour studies. These practical activities are supplemented by periodic demonstrations and Sunday evening talks by visiting scientists. The opening meeting of the year was addressed by Mr. A. Stuart, head of the Geology Department, University College, Exeter. Then throughout the year, lectures on varying scientific topics were given.

The *Magazine* reports "Meteorological Records", by D. S. R. Wills, which is a summary of the local weather during October 1952–September 1953. In the bird-ringing work, 164 birds were ringed—125 from traps and 39 from nests. The Ornithological Section also gives a detailed analysis of nest record cards for 1953 (J. Beek), and an account of the birds of the Culmstock area. A paper entitled "A Study of the Influence of Light and Soil Properties on the Growth of Bracken" presents results of an excellent piece of field and experimental work by D. P. T. Burke. The realization that biology is the study of plants and animals living together in a community (rather than the uninspiring study of type specimens from books or, at most, dead bodies and pickle jars) comes out well in C. N. A. Clement's paper on "The Part Played by the Oak Tree in the Natural Plant and Animal Community of a Woodland". D. Knight Jones records some good experimental studies in his "Investigation of the Post-Floral Movements shown by the Garden Nasturtium". C. L. Honeybourne reports some "Observations on the Circulation of Nitrogen in the Grand Western Canal"; the field work here was carefully planned and carried out, and the observations include estimation of nitrogen in the water and of plankton. This excellent paper is accompanied by a table and two graphs. In the Spring Term of 1952, J. M. Saxon began some interesting observations on soil temperatures under natural conditions, using a thermistor.

Blundell's *Magazine* is a model of its kind and reflects great credit on the methods of science teaching in that School, for which Dr. M. Ashby, the biology master, is to be specially selected for congratulation.

Fungi Pathogenic to Man and Animals

A COLLABORATION of fungi is maintained in the Laboratory of Mycology of the Instituto Oswaldo Cruz (Caixa Postal 926, Rio de Janeiro, Brazil: List of Cultures, 1953). The workers in this laboratory are specially interested in the maintenance of cultures of fungi pathogenic to man and animals, though the list, which is a considerable one, contains many others, including plant pathogens. Scientists and institutions are asked to send cultures not included in the list. Cultures from the Institute's collection will be sent "to all institutions and scientists upon request and free of any charge".

A New Modelling Medium

A NEW modelling medium called 'Vinagel' is described in the November issue of the *Museums Journal* by Dr. H. F. Steedman, of the Zoology Department, University of Glasgow. At present it can be obtained in four grades, Nos. 116, 118, 500 and 577, from Vinyl Products, Ltd., Butter Hill, Carshalton, Surrey. To use the No. 116 grade it is sufficient to press it on a coin or other hard material, peel it away gently and bake in an oven for about twenty minutes at 170° C. On cooling, it will have the consistency of stiff rubber, will be highly resistant to deformation and virtually insoluble. With the softer varieties the material may be painted or dabbed with the 'Vinagel' until a sufficient thickness is obtained, and then the original and its covering must be baked as before. Its great optical resemblance when cured to bone suggests that one of its most important biological uses lies in osteology, though it will be certain to be of service to sculptors, artists and museum technicians.

Announcements

We regret to announce the following deaths:

Mr. S. F. Ashby, formerly director of the Imperial Mycological Institute, on March 6, aged seventy-nine.

Prof. E. P. Cathcart, C.B.E., F.R.S., emeritus professor of physiology in the University of Glasgow, on February 18.

Prof. J. L. Coolidge, emeritus professor of mathematics in Harvard University, aged eighty.

Prof. O. Diels, emeritus professor of chemistry in the University of Kiel, on March 7, aged seventy-eight.

Dr. N. G. Horner, formerly editor of the *British Medical Journal*, on March 7, aged seventy-two.

OWING to the increasing activities of the Society of Dyers and Colourists (19 Piccadilly, Bradford 1), the post of editor and general secretary of the Society, held by Dr. C. J. W. Hooper, has been divided, with Dr. Hooper continuing as editor and technical officer. The new post of secretary of the Society is being filled by Mr. J. W. Nicholls, who until recently has been working in Newcastle upon Tyne as secretary and organizer of the Federation of Master Builders.

CHANGES in the chairmanship in research boards of the Department of Scientific and Industrial Research have been announced as follows: *Building Research Board*, Sir Herbert Manzoni, city engineer of Birmingham, in succession to Mr. W. K. Wallace, chairman since 1949; *Food Investigation Board*, Dr. R. Holroyd, director of research, Imperial Chemical Industries, Ltd., in succession to Sir Frank Engledow, chairman since 1947; *Geological Survey Board*, Sir Walter Drummond, deputy chairman of the National Coal Board, in succession to Sir Arthur Trueman, chairman since 1943, who has retired from the post owing to ill-health; *Road Research Board*, Mr. E. J. Powell, county surveyor of Glamorgan, in succession to Sir Frank Smith, chairman since 1946.

THE United Steel Companies, Ltd., have recently endowed a fellowship for research in ferrous metallurgy at the University of Sheffield, and Dr. A. R. Entwistle, who for some time past has been engaged in metallurgical research in Sheffield, has been appointed as the first holder. Dr. Entwistle will study the effect of interstitial elements on the formation of martensite.

As in former years, a course in tropical hygiene for laymen will be held by the Ross Institute of Tropical Hygiene, London, during July 26–30. The course is for workers in the tropics holding posts which entail looking after the health and welfare of others. Morning sessions will be devoted to malaria and its control, and in the afternoons other tropical diseases and problems, such as hookworm, bilharzia, nutrition, housing and sanitation, and protection against heat will be dealt with. There is no fee for the course. Further information can be obtained from the organizing secretary, L. G. Ponsford, Ross Institute of Tropical Hygiene, London School of Hygiene and Tropical Medicine, Keppel Street (Gower Street), London, W.C.1.

ERRATUM. In the communication entitled "Possible Existence of a Transition Point between β - and γ -Sulphur", by R. S. Bradley, Dr. N. H. Hartshorne and M. Thackray (*Nature*, February 27, p. 400), the legend on the ordinate of the graph should read "Log-rate (mm./hr.)".

ATOMIC WEAPONS*

IN ordinary explosives, energy is released at high speed as a result of the rearrangement of unstable molecules into more stable forms. Since the energy is of the same order of magnitude for all chemical reactions, chemical explosives much more powerful than those available at present will never be found. In atomic weapons, however, energy is generated by the rearrangement of particles in the atomic nuclei. Nuclei are always lighter than their constituent particles, and this mass defect is a measure of the energy that would be liberated if the nucleus could be built up from its components. Since the mass defect is greatest for elements of medium atomic weight, there are two possible sources of atomic energy, namely, the building up of nuclei of medium elements from lighter ones and the breaking down of heavy elements to medium ones. The latter is the fission process on which the atom bomb is based.

To produce an explosion, the release of energy must be practically instantaneous. The fission of uranium-235 or plutonium-239 can be made to fulfil this requirement if a chain reaction is set up propagated by fast neutrons. At each fission, two or three fast neutrons are liberated, and if the mass of the fissionable material is great enough to ensure that more than one of these neutrons produces further fission, a chain reaction is initiated which runs its course in a few millionths of a second, producing a shock wave of unprecedented destructive force.

In January 1950, the President of the United States announced that he had directed the continuation of work on all forms of weapons "including the so-called hydrogen bomb". This made public the possibility of producing energy by the fusion of light

* Summary of a lecture by Prof. O. R. Frisch, O.B.E., F.R.S., being the second of the series of public lectures arranged by the Atomic Scientists' Association and the Department of Extra-Mural Studies of the University of London (see *Nature*, February 27, p. 336).

elements into heavy ones. In January 1953 it was announced that a thermonuclear test had taken place at Eniwetok, and in August 1953 Malenkov stated that "the U.S. no longer has the monopoly of the hydrogen bomb".

Little is known publicly about the construction of the hydrogen bomb; but most probably it is based on the fusion of hydrogen nuclei into helium nuclei, taking place at very high temperatures. The temperatures necessary for such reaction are of the order of millions of degrees and can only be produced by a fission bomb; the hydrogen bomb must thus be triggered by a fission bomb. It is fairly certain that hydrogen is the main material for a thermonuclear bomb, for the fusion of heavier elements requires much higher temperatures and produces less energy; but ordinary hydrogen is not suitable, and either deuterium or tritium have to be used.

The main advantage of the hydrogen bomb is that there is no essential limit to its size. It is a very safe explosive, for it will never go off unless fired by the fission bomb. The latter, on the other hand, is by nature unsafe and goes off the instant it is assembled, which puts a practical limit to its size. The load capacity of modern aircraft would, however, limit the explosive power of the hydrogen bomb to about a thousand times that of the fission bomb. The radius of damage of such explosive would thus be ten times greater than that of a fission bomb, that is, about ten miles for severe damage.

Against the background of Nature, atomic weapons are small. An average local thunderstorm releases as much energy as a plutonium bomb; a hurricane or an earthquake, a million times as much. Nevertheless, they are frightful weapons, capable of inflicting terrible destruction and wholesale death.

MANAGEMENT OF PUBLIC CORPORATIONS

THE Select Committee appointed in December 1951 "to consider the present methods by which the House of Commons is informed of the affairs of the Nationalized Industries and to report what changes, having regard to the provisions laid down by Parliament in the relevant statutes, may be desirable in these methods" issued last year a second report* which indicates very clearly how far we yet are from a satisfactory solution to the problem of parliamentary accountability. The Committee's first report was confined to the Parliamentary 'question' and stressed the limitations of this method of keeping Parliament informed and securing public accountability, rather than offering a fresh contribution towards the solution of what is increasingly recognized as a problem of national importance. In this first report, it was apparent from the evidence submitted to the Committee that, while the import-

ance of the public issues involved is widely appreciated, there is also a considerable difference of opinion as to the means for improving the present unsatisfactory situation, and also some misunderstanding as to the possibility of reconciling in a practicable way the independence and flexibility which are essential if a public corporation is to be characterized by initiative and enterprise, with complete answerability to Parliament.

This is also characteristic of the Select Committee's second report. The clash of opinion is no less marked, and the Committee's recommendations are obviously contrary to the opinions, strongly held and sometimes vehemently expressed, of important witnesses. The value of the report may well lie in the material for critical examination and further constructive thinking which it affords in its minutes of evidence, rather than in its somewhat tentative recommendations. The most encouraging feature of the report is, in fact, the indication it supplies of a disposition to examine the whole problem objectively and to keep

* Report from the Select Committee on Nationalized Industries, together with the Proceedings of the Committee, Minutes of Evidence and an Appendix. Pp. xviii+118. (London: H.M. Stationery Office, 1953.) 4s. net.

criticism of the nationalized industries of Great Britain as free as possible from party politics.

To the reality of the general desire for more information about the nationalized industries the report freely testifies: this is essential for informed and constructive criticism. The Select Committee was equally concerned that the nationalized industries had insufficient opportunity of presenting their case to Parliament and the public, and were exposed to public pressure in various ways and to much irresponsible criticism. Lord Hurecombe, as well as Mr. Hugh Molson, parliamentary secretary to the Ministry of Works, gave evidence on this point; such arguments, and the need for accountability arising from the vast amount of capital and of income and expenditure involved in concerns which are under public ownership, and the direct impact of their charges upon everyday civilized life, quite apart from the Treasury guarantee of interest paid on their stock, led the Committee to consider the appointment of a Standing Committee of the House of Commons or of both Houses of Parliament to examine the nationalized industries and keep Parliament informed upon them.

The arguments for such a committee were advanced by Mr. Molson in his evidence, on the assumption that it would be concerned with elucidating fundamental problems of policy. Mr. Molson was evidently also of the opinion that such a committee would afford Parliament the means, from time to time, of taking stock of the situation, in much the way that Mr. Herbert Morrison had urged in 1950 in suggesting a periodic committee of inquiry at about seven-yearly intervals for each public corporation. Lord Hurecombe, who also supported the suggestion, thought that apart from helping to meet the legitimate demand of Parliament for further knowledge, the continuity of personnel on such a committee could contribute not merely to informed debate, but also to objective debate and to the removal of a controversial atmosphere so that constructive suggestions could be more readily made and received.

Strong representations were made in evidence to the Select Committee that the establishment of a permanent committee of inquiry into the nationalized industries would be both contrary to the spirit and intentions of the acts under which the industries were nationalized and also an innovation in, and hostile to, the general pattern of the British constitution. Lord Reith suggested that the appointment of such an *ad hoc* select committee was in effect a negation of Parliament's deliberate renunciation of the right of direct interference when it passed the nationalization acts. He regarded it as tantamount to institutionalizing the Parliament question and likely to lead to a direct collision between the industries and Parliament.

Although Lord Reith was strongly of the opinion that if any committee were set up it should be a committee of both Houses, that would not avoid the difficulties to which Lord Reith directed attention. Moreover, the committee must be an official committee: an unofficial committee is impracticable, because the contacts between the chairmen of the public corporations and Parliament must be upon an official basis. Lord Reith's own view was that a Royal Commission with wide terms of reference would be a much more effective means of achieving the desired purpose, and he elaborated the argument he advanced before the Public Accounts Committee

three years ago as well as earlier. Failing this, he suggested that there might be some minister responsible for the public corporations and provided with a small staff for the purpose, in much the same way as the Lord President of the Council is responsible for the work of the Medical Research Council, the Advisory Council for Scientific and Industrial Research and other bodies.

Lord Reith did not recommend the appointment of such a minister. He merely indicated that it was one way of dealing with the problem, and it was quite clear that such a proposal would still have to solve the difficulty of the parliamentary 'question' if control over day-to-day management is not to develop. He was obviously impressed with the possibility of a Royal Commission reaching a more satisfactory solution and providing constructive proposals on the basis of much more careful study and far-reaching objective inquiry than the complex and important issues involved had as yet received. The Select Committee was obviously impressed with Lord Reith's view and particularly the possibility it offered for more searching inquiry by fresh minds, not limited necessarily to Parliament itself. Nevertheless, in spite of similar arguments advanced by Mr. Herbert Morrison, its own recommendation was for the appointment of a Standing Committee and one of the House of Commons only.

Mr. Morrison did not specify a Royal Commission, but equally had in mind the advantage of a commission which was not limited to members of Parliament and which would be periodic rather than permanent. He emphasized that the responsibility for efficiency should lie on the industries themselves, and suggested that co-operation among the national boards might lead to the establishment of a common efficiency unit which would avoid the dangers inherent in one established for a particular corporation. Moreover, Mr. Morrison raised an objection to the proposed Standing Committee which went deeper and obviously impressed the Select Committee. He recognized that there is also a danger that, by further increasing the duties of Parliament, the efficiency of Parliament itself would be impaired: he was dubious as to whether Parliament is the appropriate body to consider closely the actual management of a complex industrial concern, but he was equally concerned that Parliament as well as the public corporation might break down.

There is much to reinforce Mr. Morrison's concern and to suggest that without further decentralization the working of the whole Parliamentary system of Britain may be endangered. Like Lord Reith, he saw clearly that the appointment of a Standing Committee, no matter how carefully its terms of reference were drawn, must raise afresh the whole question of the responsibility for managing and directing the operations of the public corporation. Accountability itself might well become less certain or secure, and as Lord Reith pointed out, a select committee which started as a friendly communicative body might end by investigating and controlling.

The main argument against the Select Committee's recommendation is, however, as the Committee itself admits, that the proposal would impede the working of the nationalized industries and destroy initiative in them. Mr. Morrison, for example, was apprehensive that the existence of such a Parliamentary committee would encourage exactly the conventional, unadventurous type of mind, with its reliance on routine and precedent characteristic of government depart-

ments which Parliament wished to avoid when it created public corporations. Sir Geoffrey Heyworth, chairman of Unilever, Ltd., and a part-time member of the Coal Board, was no less concerned that such a committee might be led inevitably into inquiries on wide decisions of policy, with repercussions that would discourage initiative and the taking of decisions. Any form of detailed control was likely to entail mediocrity or worse, and he looked rather to the public corporations settling down in due course as integrated bodies and developing their own internal controls and their own adequate relationships with the outside public. The more they could develop into autonomous units the better the chances of success.

Sir Geoffrey Heyworth did not conceal the probability that integration might take a very long time. He recognized, too, that autonomy and responsibility to Parliament are scarcely consistent, and it is perhaps natural that a Select Committee should give the greater weight to Parliamentary responsibility. Having rejected any extension of the Parliamentary question as impracticable, the Select Committee reached the conclusion that the only means of providing Parliament with the desired further information for parliamentary accountability was by means of a Parliamentary Committee. Although some witnesses, like Capt. Crookshank and Lord Hurcombe, were in favour of a committee of both Houses of Parliament, and the practicability and even the advantages of such a committee were admitted by Sir Edward Bridges in his evidence, the Select Committee rejected this suggestion and proposed to exclude members of the House of Lords on the rather slender grounds that some of the work of the proposed committee would be of a financial character.

The Select Committee reached this decision with some regret, and the point is one that merits reconsideration in view of the admitted advantages which wider membership would afford. Moreover, it is clear that in its present form the Select Committee's proposal is concerned with the wider context in which the policy of the corporations is determined and not simply with the inquiries into accounts such as the Committee of Public Accounts makes in respect of government departments. The hope is expressed that the proposed committee's dealings with the Boards will lead the Boards to regard it as a body which they can approach to explain their policies and their difficulties. It is strongly recommended that the committee should avoid the investigation of matters which fall into the category of detailed administration.

The Select Committee's proposal is thus for something more than a committee authorized to conduct those inquiries from which the Committee of Public Accounts is debarred. Although the proposed committee would be provided with staff, including an officer of the status of the Comptroller and Auditor General, and it is suggested that the statutory auditors of the corporations, in preparing their annual reports, should give such further information "as may be of use to the Committee and of interest to Parliament"; provided the approach does not differ too widely from those of ordinary professional auditors, the committee has obviously much the same kind of body in mind as the late Lord Lindsay of Birker suggested in a debate on the nationalized industries in 1950. It is anxious to establish friendly and informal relations between the committee and the various boards, though it does not contemplate any-

thing quite so intimate as the Advisory Board, on the model of the University Grants Committee, which Lord Lindsay then suggested.

The Select Committee comments on the limitations which the increasing calls upon the available time of members of the House of Commons place upon any investigation of the nationalized industries by a committee of that House or any sub-committees it may establish. In spite, however, of leanings towards Mr. Morrison's idea of a septennial commission, or Lord Reith's advocacy of a Royal Commission, it does not appear to recognize that this limitation strengthens the argument for bringing in experienced minds from outside the House of Commons. It is content to recommend in effect merely the establishment of a body which will do for the nationalized industries much what the Committee of Public Accounts does for the Departments of State.

The expediency or practicability of such closer financial accountability or the manner in which further information regarding the accounts of the nationalized industries should be supplied to Parliament and to the public is not the vital issue to-day. The purposes of nationalized industry are economic, but it will not be sufficient merely to ensure that the industries are economically efficient: the suspicion or belief that they are inefficient and uneconomic must be dispelled, and the real difficulties arise because we are dealing in a democracy with a system of State-owned monopolies in an economy that is partly free. The information required is such that will give public confidence that monopoly is not abused, or that any abuse will be promptly rectified. Moreover, while the criteria of efficiency have yet to be established, even on practical considerations problems of organization such as size and decentralization have as yet reached no final solution. But, above all, the nationalized industries are differentiated from earlier experiments with the public corporation by the extent to which their policy impinges on public policy. Only within limits can their policy be determined autonomously: inevitably it is determined broadly and to a varying degree by decisions which the Government itself must take. When, as in the matter of fuel, either Minister or Government fails to produce a policy, the responsibility for lack of initiative or co-ordination must still largely rest upon the Government.

On this ground alone, the Royal Commission which Lord Reith advocates so strongly has much to commend it. The meaning of public accountability where the nationalized industries are concerned is still too vague for more than tentative proposals for achieving it to be formulated, and there is neither general agreement as to the exact purposes to be served nor any clear conception as to those purposes. It might well be found, for example, that even if the internal efficiency unit which Mr. Morrison advocates proved practicable, it would yield no substantial advantage commensurate with the effort. The studies which have already been made by the Acton Society Trust have to some extent cleared the ground, but much more is still required in the way of such objective examination; the slackening of Party conflict over the issue may well encourage a wider examination of the many complex issues involved in the decision as to the most appropriate means by which Parliament and the public can be satisfied that the public corporations in general are efficiently run and the public interest truly served.

LABORATORY ANIMALS BUREAU

THE Laboratory Animals Bureau, a unit of the Medical Research Council housed at the Council's laboratories at Holly Hill, Hampstead, London, N.W.3, has published Vol. 1 of its "Collected Papers"*. As Dr. H. J. Parish explains in his foreword to the volume, the Bureau was established in 1947, and its first director was Prof. R. E. Glover, who is now professor of veterinary pathology in the University of Liverpool. After a vigorous start on its useful career under Prof. Glover's experienced guidance, the Bureau is now directed by Dr. W. Lane-Petter, and most research workers who use experimental animals know the work of the Bureau so well that its value needs no emphasis. There will, nevertheless, be many who will welcome the information contained in this volume.

In the first article, Dr. W. Lane-Petter discusses the problems with which the Bureau has to deal, the uses to which experimental animals may be put, the sources of their supply, the problems of procuring them and of maintaining adequate supplies of them, and certain special problems, such as the provision of uniform strains and animals free from infections.

When, however, these problems have been overcome, the further problem remains of managing and properly feeding the animals in the laboratory, and Prof. A. N. Worden deals with this subject of diets and management in an article based on his experience and special study of the subject. Mr. A. E. Mundy, secretary of the Laboratory Technicians Association, which was founded in 1950 to improve the training and status of the assistants who do the important work of looking after laboratory animals, discusses the functions of these assistants, who are, as every research worker will agree, essential factors in all schemes of research which must employ experimental animals. Mr. J. Scarnell discusses the equally important subject of the control of infections of laboratory animals with diseases which may suddenly wreck experimental work. In an article on the provision of animals for research, Dr. J. S. Paterson, of Porton, gives, from his wide experience of both research and the provision of animals for others, a valuable account of the various problems that arise. He discusses the functions of breeders and dealers and the accreditation scheme for commercial breeders that is supervised by the Laboratory Animals Bureau. The Bureau proposes to issue "Collected Papers" each year, and material for inclusion in it may be submitted to the director.

The Bureau has also issued a "Catalogue of Uniform Strains of Laboratory Animals maintained in Great Britain"†. The Catalogue contains details of the origin, pedigree, description and methods of management of laboratory animals maintained in Britain which are "thought to show a reasonable degree of uniformity". It is not claimed that this is a complete list for the whole country, but it is hoped that laboratories that have not yet sent in contributions to the Catalogue will do so in the future. Strains kept by commercial breeders will also be included if they qualify for inclusion. As the Catalogue says: "A useful degree of uniformity is an essential criterion. Hence many of the strains

listed are not strictly inbred, but are random mated in closed population and found by those maintaining them to be sufficiently uniform for their purposes. Whether or not strict sib-mating would increase the degree of uniformity to such a degree as to justify the additional trouble involved is an open question. The answer probably lies in the use to which the animals are to be put. But there can be no doubt that the conditions of management are profoundly important and it is for this reason that much space in the Catalogue is taken up by providing such details."

A feature of these two publications is the picture they give of the humane spirit in action, not only on behalf of the animals with which the Bureau is concerned, but also against disease and the suffering it causes to man and other animals. They also show the valuable results that come when medical men and veterinarians work together in what is, after all, a common field of beneficent activity.

G. LAPAGE

POPULATION OF LONDON, 1951

THE first of the "County Report" series of tables based on the 1951 Census covers the Administrative County of London*. The tables relate mainly to the numbers, distribution according to age, sex and marital condition of the population of the county, and to the structure of the private households and the conditions in which they were housed. In addition, there are tables relating to birthplace and nationality and to the "Social Class" distribution of the male population. Separate figures are given for the City of London and the twenty-eight metropolitan boroughs. Statistics relating to occupations, fertility and other matters on which information was obtained at the Census are not included in the County volumes but will be published in a series of special reports.

The present volume is of general interest as providing a summary account of some of the social changes which have occurred in London during the past twenty years. Many of these changes were either directly due to the Second World War or greatly accelerated by it. The continuous decline in the population of the Administrative County which began between the 1901 and 1911 Censuses has continued. The total population enumerated in the 1951 Census was 3,347,982 as compared with 4,397,003 at the 1931 Census. The estimated resident population of Greater London, however, increased slightly between these Censuses, the proportion in the outer ring having increased from 47 to 60 per cent of the total. The decline in the population of the inner area has been unevenly spread over the various metropolitan boroughs; the weighted average per cent decline was 23.9 per cent, but Poplar, Shoreditch and Stepney lost more than 50 per cent of their 1931 populations, whereas Hampstead, Lewisham and Woolwich gained 7, 3.5 and 0.7 per cent, respectively.

The reduction of the total population and its unequal incidence in different parts of the County, and the unequal incidence of enemy bombing and post-war building have combined to modify the pattern of housing conditions which existed in 1931. Crude averages representing percentages of total population living at given numbers per room may be misleading indicators of the extent of overcrowding.

* General Register Office. Census 1951, England and Wales. County Report, London. Pp. 1+90. (London: H.M.S.O., 1953.) 22s. 6d. net.

* Laboratory Animals Bureau. Collected Papers, 1953. Vol. 1. Pp. 66. 5s.

† Catalogue of Uniform Strains of Laboratory Animals maintained in Great Britain. Pp. III+70. 2s. 6d. (Laboratory Animals Bureau, M.R.C. Laboratories, Holly Hill, London, N.W.3; 1953.)

Nevertheless, it is interesting to see that the percentage of all persons living at more than two per room in the whole County was 2.55 per cent in 1951 against 13.13 per cent in 1931. Some remarkable re-ranking has occurred among the boroughs in respect of this index. The highest figures are recorded in Paddington, Kensington and St. Pancras, whereas in 1931 the worst conditions were found in Finsbury, Shoreditch and Bethnal Green. In general, the rank correlation between the indexes for the two years is fairly high.

The 1951 Census sought to obtain some wholly new information about housing conditions by asking questions about certain household arrangements. The results for London are presented in tables showing (separately) the percentage of households having exclusive use, sharing or being entirely without piped water, cooking stove, kitchen sink, water closet and fixed bath. It is not certain that the results of the new inquiry have come up to the expectations of the designers of the census form either on statistical grounds or as sources of unambiguous information about social conditions in different areas: statistically, the value of the results has apparently been somewhat impaired by misunderstanding of the questions on the part of householders; and sociologically, it appears that the results need to be interpreted in the light of other information about household structure. It is, in fact, not nearly as easy as might have been supposed to decide whether relatively extensive sharing of facilities, or even their absence, is an unambiguous sign of poor social conditions in any given area. Some form of factor analysis might be useful in determining significant criteria from this new material. The new tables showing the distribution of heads of households by age, sex and marital condition might prove specially useful in that connexion.

The report contains tables of the percentage of the male population aged seventeen to nineteen in the various boroughs who were engaged in full-time education. They range from 30 per cent in Hampstead to 1 per cent in Shoreditch, and the figures are highly correlated with the percentage of occupied males in the boroughs who stated their "terminal education age" as being seventeen years or more. The boroughs with high "secondary education" percentages tend also to be those with high proportions of professional workers and those with relatively high proportions of residents from outside London.

FLAX IN NEW ZEALAND

NEW ZEALAND has a native plant, *Phormium tenax*, the leaves of which yield a useful cordage fibre, long known in New Zealand as 'flax' and in commerce as 'New Zealand flax'. This fibre is very different from true flax, the best fibres from *Linum usitatissimum*. The confusion of terms was immaterial before 1940, but in that year New Zealand began to grow crops of the true flax, designating it 'linen flax' to differentiate it from the native fibre. Outside New Zealand it is now customary to refer to the native fibre as 'Phormium' fibre or 'New Zealand hemp'—'hemp' being used as a general term to include all the cordage fibres, while the original hemp fibre from *Cannabis sativa* is described as 'true hemp'.

In Great Britain, as a consequence of the cutting off in 1940 of flax supplies from the Continent of

Europe, the Ministry of Supply appealed to New Zealand to grow fifteen thousand acres of flax to help fill the gap. The response was prompt, favourable and energetic. Fortunately, three years before the War the New Zealand Department of Scientific and Industrial Research had arranged for the officers of its Agronomy Division to make investigations of flax growing and processing in association with the Fields Division of the New Zealand Department of Agriculture; and when the crisis came, the officers were able to advise with confidence where and how the flax could be grown, and what yields of fibre and seed might be expected. But no organization was in being; in so novel a situation the difficulties were immense, for the farmers had no knowledge of the flax crop and the engineering firms had no experience of making the processing machinery. The problem was threefold—to establish an industry, to grow the crop and to process it; and the problem was successfully solved, the success being due to splendid team-work.

A report of how all this was done has been prepared by Mr. J. W. Hadfield, formerly director of the Agronomy Division, N.Z. Department of Scientific and Industrial Research*. To start with, a Linen Flax Management Committee was set up, to which Mr. Hadfield was seconded as director of linen flax production. It was arranged that the Department of Agriculture should organize and control all field operations, the arranging of contracts, sowing and harvesting; that the Marketing Department should handle the export of fibre, tow and seed; and that a Linen Flax Section should be established under the Department of Industries and Commerce to erect mills and carry out all factory operations. The co-operation was secured of the Public Works Department, which undertook the purchase of sites, letting tenders, and supervising the construction of factory buildings and retting tanks. The machinery problem was solved by the help of the Railways Department workshops, which supplied locomotive boilers to the mills and manufactured flax-processing machinery based on European models.

In a few months the new industry was established. The speed with which this co-operative enterprise was developed is revealed by the captions of two photographs in the report: "Instructions to grow flax were received in June 1940. Sowing commenced four months later, and harvesting in January 1941. . . . Flax mills were being built while the crops they were to process were growing. The first fibre was delivered from the mills in March 1941".

Part 1 of the report is a plain record of plans and achievements and describes the fascinating details of how the industry was established, without omitting mention of the inevitable disappointments and criticisms. Part 2 describes the application of the general principles of flax growing to the particular conditions of the seventeen areas in the South Island in which the flax was grown. Part 3 describes the processing methods followed at the mills set up in the various growing areas.

It was inevitable that the hasty but successful improvisation of flax production in 1940 should be carried out without immediate regard to cost; more than thirteen thousand acres were actually sown with flax in 1940, and even greater acreages in succeeding years. But after the War, when it became necessary

* *Linen Flax Fibre Production in New Zealand*. By J. W. Hadfield. Pp. xviii+125. (New Zealand: The Linen Flax Corporation of N.Z., and the N.Z. Departments of Agriculture, Industries and Commerce, and Scientific and Industrial Research, 1953.) n.p.

to effect economies, production was gradually reduced until now only three areas grow the crop. But New Zealand had accomplished what it set out to do; and it made the very welcome addition of 10,274 tons of highly useful flax to the inadequate British supplies.

The report is not only a permanent record of New Zealand's war effort in flax; it is also a mine of information, well printed, lavishly illustrated with excellent photographs, invaluable as a guide to flax production, and indispensable to everyone concerned with flax in New Zealand. In short, Mr. Hadfield is to be congratulated on a very fine publication, as are all who had a share in bringing to a successful conclusion the flax enterprise with which it deals.

A. J. TURNER

BOTANICAL HISTORIOGRAPHY

DR. F. VERDOORN, whose name is well known to botanists, has outlined some of the problems of botanical historiography and has entered the plea that more attention be paid to phytohistory both in its special and more general aspects (*Archives Internationales d'Histoire des Sciences*, 15, 448; 1951; published with the assistance of Unesco). He has also indicated an extensive range of projects to which those who are interested in matters botanical, but who are without laboratory facilities for practical research, might well contribute. Some indication of his point of view is given in the following quotations.

"What is botany? Let us not present a definition which is correct according to the philosophers of science, but let us give the very simple, to some of you perhaps annoying, equation:

Botany = Plants + Men."

"Plants only, we must not forget, do not yield a grain of botany. Yet we will all agree, they are an important part of the equation. Phytohistory, in the widest sense of the word, is the history of the interaction between plants and man's intellectual powers. The history of the vegetable kingdom itself is not phytohistory; depending on our outlook it is historical plant geography, genetics, or paleobotany, but as soon as the human element enters we come into fields, which though they may not all be phytohistory, in the strict sense of the word, will nearly always be closely connected with it, as: ethnobotany, the history of cultivated plants, the history of plant names, etc. . . ."

"Phytohistory aims to contribute to these disciplines, but as far as the phytohistorian is concerned, they are borderlands. His real task is to present an integrated picture of the history of the plant sciences as a whole, of their inter-relations with other sciences and then of the history of each of the branches of scientia amabilia. Thereafter, as we cannot consider any science apart from its makers, we come to other aims, such as studies in the history of regional botany, the history of the major schools of botany, the history of botanic gardens (the only botanical institutions of former generations), the history of botanical expeditions, and last, not least, the history of the individuals—botanici typici et atypici—who made the science of plants what it is to-day. . . ."

"If we now agree that the history of the plant sciences has quite a few possibilities, each of them worth further study and research, we may well consider what we can do towards its promotion. These days there are much more than one hundred thousand

plant scientists in the world. Some of these contribute by research, others by teaching, again others by organizing work. Many are tied up, a good part of the day, by what we call routine tasks, and others who have time for research do not have the equipment or resources. I believe that there are quite a few hundred good plant scientists amongst us to-day who remain utterly non-productive, but who could well apply their training and energy, reducing the frustration from which they are suffering, to serious work in the history of biology. Let us consider, therefore, in the first place, what can individuals do?"

Among these things, Dr. Verdoorn lists studies of ethnobotany, the history of cultivated plants and of plant names, of botany and biology as a whole, of individual botanical disciplines, of local and regional botany, of the major schools of botany, of botanic gardens, of botanical expeditions, and "critical biographies of botanists of the past, which yield basic data needed for work in all the other branches of the history of the plant sciences". The importance and value of international co-operation in advancing the aims of phytohistory are also emphasized.

"The first World War destroyed more international co-operation and goodwill than has ever been rebuilt since 1914. And that brings me to another point. In large countries like the U.S.A., England, France and Germany, where mostly national textbooks are used, even graduate students no longer develop a clear concept of the purely international character of science. Yet, a clear realization of the interdependence of scientists is absolutely necessary to train scientists well, to give them positive and progressive ideas about professional ethics, and to counteract the scientist's instinctive inclination towards petty jealousies which only too easily develop into perennial feuds. Any work in the history of a branch of science which gives our students an acquaintance with preceding generations can help immensely in creating a clear understanding of the mutual international dependence of science and scientists and in building positive ideals among the men who, more than any other group in society, will always be the pioneers in building and reconstructing international relations and co-operation."

GENERATION OF RADIO NOISE BY COSMIC SOURCES

IN a recent paper¹, I concluded that the observed spectrum of general galactic radiation at metre wave-lengths precludes the possibility of a thermal origin by free-free transitions in interstellar gas. The thermal spectrum should have the form $W \propto f^\epsilon$, where W is the observed power at frequency f and ϵ is a function of f which is always positive; the observed value, however, is negative. Another difficulty, pointed out by previous workers, is that accepted estimates of electron densities and temperatures would result in a much lower intensity than observed. The same two objections to a thermal origin apply for the major discrete sources; thus the Cygnus source near 100 Mc./s. has $\epsilon \sim -1.2$ and, furthermore, it is unlikely that the observed intensity could be accounted for with reasonable values of electron density and temperature.

Hoyle has recently² suggested a new process of thermal radio emission from colliding clouds of inter-

stellar gas which he considers overcomes both these difficulties. Electron acceleration is provided, not by individual protons, but by local concentrations of space charge. He claims that, if separation of protons and electrons is complete, then emission is increased by a factor $(v/f)^{1/2}$, where v and n are the electron velocity and density. He considers that a factor of 10^4 might be attained and so account for the observed sources in Cygnus, Cassiopeia and Taurus.

The suggestion provides an interesting extension of free-free emission theory. Under suitable conditions, both a negative value of ϵ and increased emission (above the free-free level) may occur. However, it appears necessary to revise Hoyle's treatment and particularly his conclusions concerning the radio sources.

An error in Hoyle's argument is that he compares his process, not with that of close collisions as in the theory of free-free emission, but with accelerations by small statistical concentrations of charge in volumes of dimensions v/f . Radiation by the latter process is generally so small as to be neglected in free-free theory. The numerical effect of this error is shown by comparing the average emission by a single electron by the proposed process and by free-free emission. First consider an electron moving in a nearly straight line tangential to a sphere of radius b containing n protons per cubic centimetre and no electrons. A pulse of radiation is emitted of duration $\sim 2b/v$ and peak intensity $32\pi^2 e^2 n^2 b^2 / 27 c^2 m^2$ erg sec.⁻¹, e and m being the electron charge (e.s.u.) and mass, and c the velocity of light. This radiation is spread over a frequency-range from zero to about $f = v/2b$, and so the power per unit frequency interval is about $23\pi^2 e^2 n^2 b^2 / c^2 m^2 v$ erg sec.⁻¹ (c./s.)⁻¹. This may be compared with the average power radiated by an electron by free-free emission when the density of protons is also n per cubic centimetre. Such a comparison should rather favour the Hoyle process in the example given, because the electron considered provides the maximum radiation. The majority of electrons will either pass through the sphere of protons or pass it at distances greater than the radius; these will radiate less. Also electrons moving at velocities less than $2bf$ and those passing well outside the sphere have an emission spectrum which is cut off below f and so do not contribute. These effects should more than compensate for the fact that the total number of protons in a given large volume is greater in the free-free than in the Hoyle example given.

The average free-free emission per electron into solid angle 4π is $32(2\pi)^{1/2} A_1(2) e^2 n / 3 c^2 m^2 v$ erg sec.⁻¹ (c./s.)⁻¹, where $A_1(2)$ is a factor proposed by Chapman and Cowling to limit the maximum collision distance for which contributions to the total radiation are considered. For an electron temperature of 10^4 °K. and $n = 1$, its value is 52.6 and the total emission is $1,400 e^2 n / c^2 m^2 v$. Radiation by the Hoyle process exceeds this by a factor of 0.016 $b^2 n$ or 0.002 $(v/f)^{1/2} n$ and not the factor $(v/f)^{1/2} n$ stated by Hoyle.

When applied to discrete source radiation the theory is found inadequate. For example, the intensity and size of the Cygnus source at 100 Mc./s. indicate an average brightness temperature of 4×10^4 °K. If all the electrons in the cloud have velocities of 10^{10} cm. sec.⁻¹, corresponding to a temperature of $\sim 2 \times 10^4$ °K., then the optimum value of b is 50 cm. Assuming a value of $n = 1$ cm.⁻³, then a cloud of thickness (in the line of sight) 10^4 parsecs is necessary to provide optical depth unity

and brightness temperature $\sim 10^4$ °K., somewhat lower than that observed. Throughout the whole of this excessively large gas cloud most of the protons and electrons must be grouped in separate blobs which have at least one dimension about 50 cm. Larger or smaller blobs reduce the radiation at the frequency considered. Roughly similar considerations apply for the Cassiopeia source.

The radio source in Taurus warrants special mention because its spectrum, substantially flat* from 40 Mc./s. to 1,200 Mc./s., is consistent with a thermal (free-free) origin in optically thin gas. However, such an origin would require excessively high values of electron temperature and density* and also of visual radiation†. The position is not retrieved by applying Hoyle's theory. The flatness of the spectrum down to 40 Mc./s. indicates a low optical depth and consequently an electron temperature much higher than the brightness temperature; as for free-free emission, an unacceptably high value of $\sim 4 \times 10^7$ °K. is found. The flat spectrum at 1,000 Mc./s. also necessitates proton concentrations of extremely small dimensions—less than 2 cm. in radius for electron velocities corresponding to a temperature of 4×10^7 °K.

Further quantitative difficulties are met in connection with the method of formation of the space charge concentrations, assumed due to the movement of gas clouds through a magnetic field of strength about 10^{-4} gauss. The maximum electric field which can result is VH/c , where V is the cloud velocity (about 10^4 cm. sec.⁻¹) and H the magnetic field. Electrons accelerated in this field (3×10^{-4} e.s.u.) will give only about 10^{-2} of the radiation found above for the Cygnus source. Again, the radius of gyration of a proton in a magnetic field of strength 10^{-4} gauss is about 10^4 cm. for a proton temperature as low as 10^4 °K. The magnetic field could scarcely form space charge concentrations of dimensions less than 10^4 cm. with random movement $\sim 10^4$ cm.

It would seem that Hoyle's suggestion is not acceptable and that some non-thermal process, involving ordered motions of electrons, must be invoked to account for discrete source radio emission as well as for the general background radiation.

I am indebted to Dr. J. A. Roberts, of this Laboratory, for helpful discussions.

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† Piddington, J. H., and Minnett, H. O., *Aust. J. Sci. Res.*, A, 4, 450 (1951).

* Greenstein, J. L., and Minkowski, R., *Astrophys. J.*, 118, 1 (1953).

I AM indebted to Dr. J. H. Piddington for directing attention to the omission of a numerical factor in a former communication¹. This arose from the inadvertent use of the usual optical formula for the emission by free-free electronic transitions. This led to the dropping of an important logarithmic factor contained in Dr. Piddington's $A_1(2)$ term. The remaining numerical discrepancy is largely accounted

for by my use of $f \sim v/b$ as an order of magnitude, whereas Dr. Piddington uses $2f \sim v/b$.

Before learning of Dr. Piddington's comments, I had also reached the conclusion that my former suggestion is unworkable, for the reason that I now doubt whether charge separation could occur on a sufficiently fine scale. The smallest unit of distance in an ionized gas is the Debye wave-length λ_D , given by

$$\lambda_D = (kT/8\pi n e^2)^{1/2}, \quad (1)$$

where n is the electron number density and k , T , e have their usual meanings. The regions in which charge separation was supposed to take place (according to the suggestion of my former communication) was less than λ_D by a factor of order 10^3 or 10^2 . It is difficult to see how this could occur, since λ_D is apparently the smallest distance over which one element of material can communicate with another.

It would accordingly seem that the point previously noted—that black-body emission would give intensities comparable with the emission intensities of Cygnus A and the Crab—is probably a coincidence.

Turning to non-thermal processes, there seem to be two schools of thought: the plasma oscillation school and the fast-particle school. From Dr. Piddington's last paragraph one would judge that he belongs to the plasma oscillation school. For my own part, I would favour the other possibility. It seems that progress toward an understanding of the cosmic origin of radio waves may be made by a study of synchrotron-type emission by relativistic electrons¹. This has been discussed by Alfvén and Harlofson², and also mentioned by me³. Since then, certain features of the problem have changed; notably, there is now a much greater certainty concerning the physical nature of the radio sources. This makes it worth again mentioning the advantages possessed by a fast-electron theory.

Before doing so, a criticism must be met. Electrons not only seem to be absent from cosmic rays, but also considerations of the type first discussed by Fermi⁴ would seem to provide a strong reason why relativistic electrons should not be present in interstellar space, namely, that the rate of energy loss from collisions with the interstellar gas clouds is from 10^3 to 10^5 times greater than the rate of gain of energy through 'magnetic collisions'. It may, however, be possible to overcome this discrepancy. The Fermi acceleration mechanism gives a gain-rate that is proportional to the square of the mean random dynamical velocity of the gas masses that carry the magnetic field. Fermi's original calculations were based on a mean velocity of 30 km./sec. In strong radio sources, such as Cassiopeia and Cygnus A, a velocity of 3,000 km./sec. would be more appropriate, thereby increasing the gain-rate by a factor 10^4 —more than sufficient to overcome the discrepancy. It would seem, therefore, that the above-mentioned criticism can be countered. Indeed, the special conditions required for an electron-acceleration mechanism to operate may well prove an advantage, since it apparently explains why the normal interstellar gas is comparatively weak in radio emission and why high dynamical velocities seem always to accompany strong emission, a point that has been emphasized by Minkowski⁵.

Turning now to quantitative aspects of the matter^{1,2}, a relativistic electron of velocity v radiates mainly at frequencies close to the value of v given by

$$v = 4.19 \times 10^8 B \gamma^2 \text{ c./s.}, \quad (2)$$

where B , the magnetic intensity, is in gauss, and $\gamma = (1 - v^2/c^2)^{-1/2}$, so that the electron energy is γ times its rest mass. For $v = 10^8$ c./s., and $B = 10^{-3}$ gauss, the appropriate value of γ is about 150. The power radiated by a relativistic electron is:

$$1.68 \times 10^{-13} B^2 \gamma^4 \text{ ergs/sec.} \quad (3)$$

The latter formula implies that a relativistic electron radiates an appreciable fraction of its energy in radio waves in a time of order

$$5 \times 10^8 B^{-2} \gamma^{-1} \text{ sec.} \quad (4)$$

Using the above relation between γ and v , this may be expressed by saying that an electron radiating a frequency close to v loses an appreciable fraction of its energy in

$$10^{12} B^{-2/3} v^{-1/3} \text{ sec.} \quad (5)$$

Inserting $v = 10^8$ c./s., $B = 10^{-3}$ gauss gives a time of about 10^4 years, which, cosmically speaking, is a very short interval—implying that the present process is a powerful one. Furthermore, it can readily be estimated that if the masses involved in the collision of the Cygnus galaxies are $10^{11} \times$ mass of sun, say, and if the total energy of all relativistic electrons now present within these galaxies is only a fraction, 3×10^{-4} , of the total energy of the collision, then an adequate intensity in the radio band is emitted. Thus the emission is not only rapid when considered from the point of view of an individual electron, but also can be a highly efficient converter into radio energy of the dynamical energy of mass motion of cosmic material.

While the value $B = 10^{-3}$ gauss used above may seem high, it must always be remembered that magnetic intensities much above the normal magnetic intensity in interstellar space are to be expected in high-velocity collisions. In such cases greatly compressed fields are likely to be produced.

It remains to add that these ideas can be put to a test. It is possible, given the energy spectrum of the relativistic electrons, to use the above formulae to obtain the frequency spectrum of the emitted radio waves. Suppose that the number of electrons in the range γ to $\gamma + d\gamma$ ($\gamma \gg 1$) is proportional to $d\gamma/\gamma^2$, this being similar to the normal cosmic ray spectrum. Since each electron emits at a rate proportional to γ^4 , it follows that the total emission by all electrons in the range γ to $\gamma + d\gamma$ is proportional to $d\gamma/\gamma$, which by (2) is proportional to dv/v . Hence the frequency spectrum of the radio waves should follow a dv/v dependence. This may be compared with the observed dependence of about $dv/v^{1.4}$. The agreement is satisfactory in view of uncertainty in the energy spectrum of the electrons.

It is a pleasure in conclusion to express my thanks to Dr. Leverett Davis for a valuable discussion on the subject-matter of the later sections of this letter.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Phototropy of Chlorophyll Solutions

OXYGEN-FREE solutions of chlorophyll in methanol undergo rapid, reversible photochemical changes if they are exposed to a flash of intense light¹. The reversible formation of pairs of radicals, which can be detected by the use of steady, comparatively weak illumination², is apparently preceded by the efficient photochemical production of chlorophyll molecules in a metastable (presumably triplet) state, having a half-life of about 5×10^{-4} sec. Since the experiments, upon which the foregoing conclusions¹ were based, were incomplete and, in many respects, preliminary in character, it was thought worth while to attempt to confirm and to extend them using the method³ of flash photolysis and flash spectroscopy.

The apparatus and techniques were similar to those used by Porter and Windsor⁴ in their investigation of solutions of aromatic hydrocarbons. The purified samples of the chlorophylls and the pheophytin *a* were prepared by Mr. K. Owens at the Department of Chemistry, University of Minnesota. The coproporphyrin tetramethyl ester was kindly given by Dr. Schwartz, of the School of Medicine, University of Minnesota. The several solvents were of commercial origin, of 'Analar' grade when it was available, and were used without further purification.

As is illustrated by Fig. 1, the normal ground-state absorption of these pigments is almost completely absent when the spectrum of the solution is observed immediately after a photolytic flash. While some new regions of absorption appear after flash illumina-

tion of solutions of the chlorophylls or of coproporphyrin, the more obvious change in the absorption spectra is the result of the depopulation of the ground-state. Solutions of pheophytin *a* exhibit the reverse effect; a 4.5×10^{-4} M solution of this pigment in its triplet state is practically opaque throughout the visible ($\lambda < 5800 \text{ \AA}$) and near ultra-violet regions.

Not only were the energies of these flashes comparatively small (125 joules or less), but, in addition, an important fraction of the actinic light was absorbed by the 'Pyrex' walls of the cells which contained the solutions. In a few experiments the energy of the flash was reduced to 75 joules without any appreciable decrease in the photochemical effect. Indeed, quantitative comparisons of the absorption spectra obtained by means of photographic flashes only with the corresponding spectra obtained with weak steady light showed that the photographic flash itself converted a detectable (5 or 10 per cent) fraction of the normal molecules into their triplet states.

The photochemical conversion of chlorophyll into its triplet state is at least as efficient in benzene as it is in methanol. This is in marked contrast to the steady-state formation of the radicals, which occurs⁵ detectably in methanol, acetone, etc., but not when benzene is the solvent. In the preparation of one solution of chlorophyll *b* in benzene (for which we are indebted to Dr. W. F. Watson, of the British Rubber Producers Research Association, Welwyn Garden City), an effort was made to dry the solvent and to exclude moisture from the solution. Although this solution showed the expected reduction in the intensity of its fluorescence⁶, the efficiency of the photochemical formation of the triplet state was not noticeably decreased. Solutions which were saturated with air exhibited virtually no reversible photochemical response to flash illumination (compare refs. 1, 2 and 4).

Qualitative inspection of the spectrograms indicates that the half-life of the principal photochemical transient, which is formed in degassed solutions of these pigments in benzene or methanol, has a value between 2 and 5×10^{-4} sec. In the viscous solvent cyclohexanol, a metastable form of chlorophyll existed in detectable quantities for several milliseconds after the photolytic flash.

The results reported here are qualitatively similar to those obtained⁴ with solutions of aromatic hydrocarbons. They are also consistent with the published¹ interpretation of the phototropic response of methanolic solutions of chlorophyll *b*. A spectral and kinetic analysis of the results, of which that represented in Fig. 1 is a small sample, will be reported elsewhere.

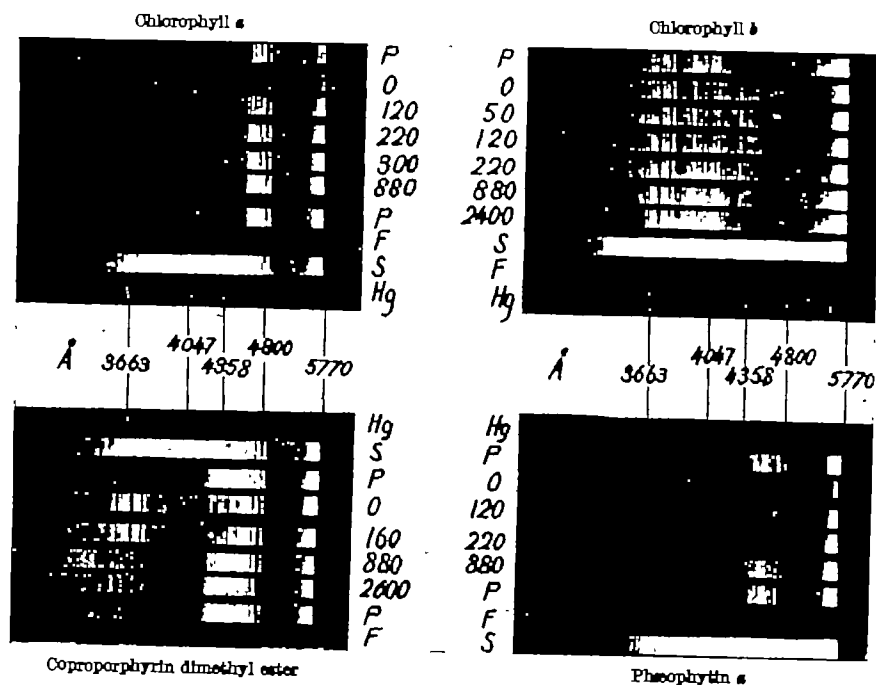


Fig. 1. Series of flash spectra. Numbers are time-intervals between flashes in μsec .; P is photographic flash through solution; S is photographic flash through solvent; F is photolytic flash alone; and Hg is spectrum of mercury-cadmium arc. The solvent was benzene, except in the case of chlorophyll *a*, where it was methanol.

This work is consequent to a series of researches which were supported by the U.S. Office of Naval Research (Project 051,028) at the Department of Chemistry of the University of Minnesota. While the present work was in progress, one of us (R. L.) was a Guggenheim Memorial Foundation Fellow on sabbatical leave from the University of Minnesota. We are also indebted to the British Rayon Research Association for a research grant to one of us (M. W.), and for the loan of apparatus used in this work.

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Filter-Paper Chromatographic Analyses of Phosphate Mixtures

PREVIOUS papers^{1,2} from these laboratories described a filter-paper chromatographic procedure for separating and determining the various components of phosphate mixtures. Improved filter paper (Schleicher and Schuell No. 589 Black- and Orange-Ribbon) and other changes have materially increased the accuracy and extended the range of components separated. A revised procedure will be published, but in the meantime an indication of its range and accuracy may be of interest.

Mixtures containing any or all of the following phosphates: ortho-, pyro-, tri-, trimeta-, tetrameta-, are separated into bands by filter-paper chromatography using the solvent tertiary butyl alcohol (80 ml.)-water (20 ml.)-formic acid (5 ml.). The blue phosphomolybdate colour is developed by ultraviolet irradiation. The amount of phosphorus in each band is then determined by a modification³ of the colorimetric procedure described by Boltz and Mellon⁴. Phosphate components of chain-length greater than four phosphorus atoms per molecule remain on the starting line and are grouped together for analytical purposes. The various components are determined with a standard deviation of 0.8 regardless of the percentage present.

Phosphate mixtures of components with one to nine phosphorus atoms per molecule can also be separated chromatographically into bands using the solvent *n*-propanol (60 ml.)-water (20 ml.)-0.88 ammonium hydroxide (20 ml.). However, the separation is not so clearly defined and thus the analyses are not considered to be as accurate, even though the precision is ± 1 per cent. The accuracy cannot be checked since pure samples of these polyphosphates are not available at present.

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Electrophoresis of Group-Specific Extracts of Streptococci

WHILE it is known that differences in the make-up of large molecules can be detected immunologically when the molecules are chemically and physically indistinguishable, it is also true that different groups of bacteria show many differences besides their immunological reactions. It is to be anticipated that the hydrochloric acid extracts which are used as antigens in precipitin reactions will be complex mixtures, and though they show the characteristic immunologically specific reactions it will not be surprising if grosser differences appear. The number and electrophoretic behaviour of the colloids present may constitute such differences. This was tested by examining extracts of nine strains from five serological¹ groups of streptococci. The strains were 28/USA of Group A, C104 and NCTC8181 (*Streptococcus agalactiae*) group B, Pearl 11 (*Str. bovis*) and 775 (*Str. faecalis*) group D, C24B and 4678 (*Str. infrequens*) group E, and H14 (*Str. lactis*) and H19 (*Str. cremoris*) of group N².

Hydrochloric acid extracts were prepared by the method of Lancefield¹ and were concentrated by ethanol precipitation; their specificity was established in precipitin ring tests with immune sera for each of the relevant serological groups. The precipitin tests were made by Shattock's³ technique and were read repeatedly between 1 and 10 min., and the negatives again after 15 and 30 min.

The extracts were submitted to electrophoresis by the usual free-boundary technique. The electrophoresis of the first batch of extracts (Fig. 1) was carried out in 0.01 M potassium phosphate, pH 8.4, containing lithium chloride at a concentration of 0.05 M. The precipitates from the ethanol treatment were suspended in the buffer and allowed to dialyse in 'Viking' tubing against the same buffer for a minimum of forty-four hours with at least three changes of buffer. The short dialyses were done at room temperature with thymol as a preservative. Frequently, dialysis was carried on for longer at 10° C. or below.

Occasionally small amounts of precipitate failed to dissolve. Frequently, the solutions were opalescent. They were subjected to a thorough centrifuging, which, however, diminished the opalescence only slightly. The electrophoretic diagrams were therefore of low contrast; one peak in this set was difficult to interpret (this has been shown with a serrated edge in Fig. 1) and another solution was impossible to analyse.

Similar remarks apply in general to the second set (Fig. 2), in which 0.05 M aminoacetic acid adjusted to pH 9.0 was used.

Tracings of the electrophoresis diagrams together with relevant data are shown in the figures. One of those for group E in Fig. 2 is notable for showing negative density gradients on the descending side. For this reason the run was stopped after only ten minutes. The buffer conductivities for the calculation of potential gradients have been determined since the experiment. Rough measurements carried out at the time indicated that in the glycine buffer all the extracts had a higher conductivity than the buffer alone. The diagrams show that the conditions were not ideal for quantitative electrophoretic analysis, but they were maintained because qualitative differences may sometimes be observed more easily under such conditions⁴.

It may be seen from the figures that interesting differences in the electrophoretic pictures occur,

though group differences as opposed to strain differences are not immediately apparent. It is clear that many more comparisons would be needed to recognize these, if, indeed, they do actually exist. Electrophoresis may, however, be of greater value in the

Paper Electrophoresis of the Oligosaccharides synthesized from Sucrose by Yeast Invertase

The interesting suggestion that the oligosaccharides

formed from sucrose may be the precursors of polysaccharides such as inulin and levan requires verification by the establishment of the identity and type of linkage of each of these compounds¹. The recent discovery of their presence in plant extracts² and human urine³ is a certain indication of their significance in metabolic processes.

Good progress, mainly by chromatographic techniques, has latterly been made in the identification of most of the compounds produced from sucrose by yeast invertase⁴. It was, however, found that a few problems of separation were left unsolvable by chromatography. The application of the recently described⁵ high-voltage technique of electrophoresis to this group of compounds has proved a definite advance on the paper chromatographic technique and has provided an alternative tool for checking the homogeneity of 'chromatographically pure' fractions.

Incompletely hydrolysed sucrose solution was prepared according to our procedure⁶ and diluted to one-tenth of the original concentration before application to the paper strip. The accompanying figure illustrates results obtained by the electrophoretic technique in comparison with the paper chromatographic method. The electrogram *C* shows eight distinctly separated spots, while the chromatogram *A* shows only six spots.

Under our conditions of incubation component IV was not formed in any detectable quantity. Throughout this communication the nomenclature suggested by previous workers^{7,8} is followed. It had been observed⁸ that on chromatograms the sucrose spot obscured another spot representing component V, which was detected by its reducing power and appeared to consist of two fructose residues. The leading edges of a number of sucrose spots were therefore extracted with water and subjected to paper electrophoresis. On development

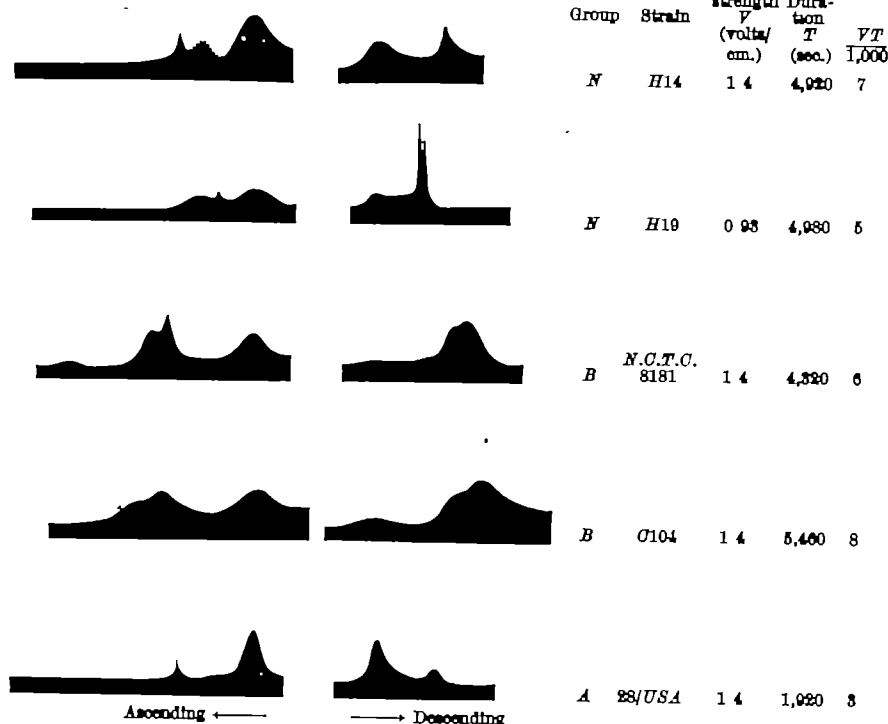


Fig. 1. Electrophoretic diagrams of specific extracts from streptococci of groups N, B and A

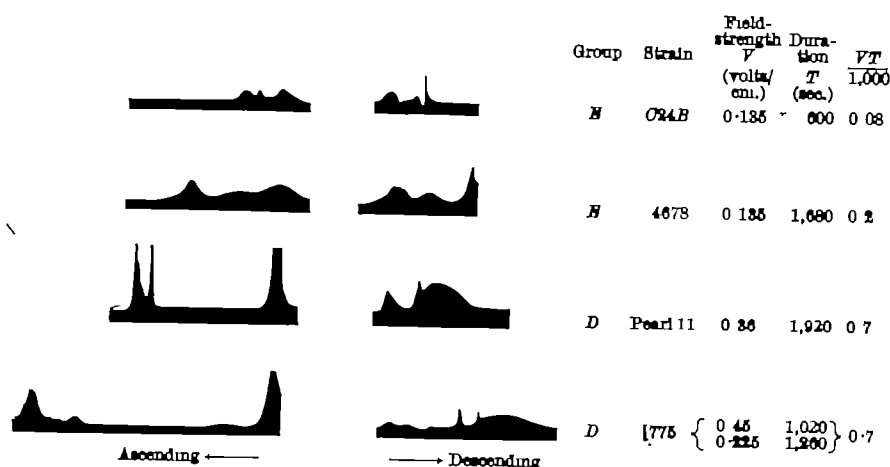


Fig. 2. Electrophoretic diagrams of specific extracts from streptococci of groups B and D

differentiation of groups of bacteria less closely related than the streptococci.

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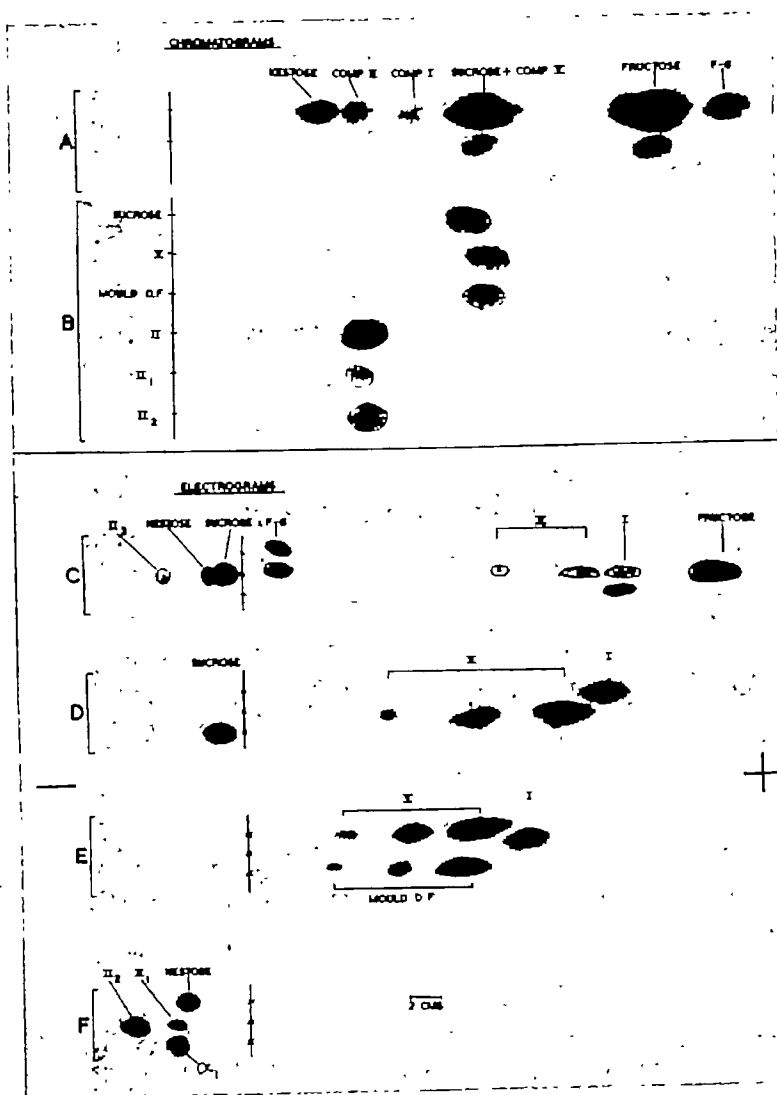
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Electrophoresis of oligosaccharides. (A) Chromatogram of a sucrose solution incompletely hydrolysed by yeast invertase. Conditions: 5 μ l. of 50 per cent (w/w) sucrose sol. run for 48 hr. with mixture α -propanol-ethyl acetate-water (7:1:2, by vol.) sprayed with α -naphthol and phosphoric acid for kestose-containing compounds. F.G. is fructosyl-glycerol. (B) Chromatogram of some oligosaccharides run under the same conditions. Mould D.F. is an assumed difructose-compound produced by mould invertase. (C) Electrophoresis of incompletely hydrolysed sucrose solution. Conditions: 40 V./cm. 20-28 m.a.m.p. Whatman No. 3MM, 2 $\times$ 23 $\frac{1}{2}$ in. strip, 0.05 M sodium borate solution, pH 9.2, 5 μ l. of 5 per cent (w/w) hydrolysed sucrose solution applied 6 in. from cathode end, 3 hr., same spray as in (A). (D) Run under the same conditions for 2 $\frac{1}{2}$ hr., 50 μ gm. of sucrose. (E) Run under the same conditions for 2 $\frac{1}{2}$ hr. (F) Applied in centre of strip and run under identical conditions for 3 hr., 50 μ gm. of kestose

with α -naphthol and phosphoric acid a series of three spots could be seen (D). The two faster spots correspond to two spots on C, while the faint spot is not made visible owing to its low concentration in the mixture applied to C. It thus appears that component V is not homogeneous but consists of two major and at least one minor constituent. Their identity has not yet been established. A sample of a difructose-compound produced from sucrose by mould invertase (supplied by Dr. J. S. D. Bacon), when examined electrophoretically, showed a similar pattern of three spots, the only apparent difference being that the second component was present in a far lower concentration (E). Chromatographic-

ally, there is no distinction between these two 'compounds', as can be seen in B.

While examining by electrophoresis the homogeneity of chromatographically separated fractions, it was found that component II yielded one major spot and one minor spot of a mobility slightly lower than that of kestose (F and B). Bacon⁴ succeeded in separating II by the gradient elution technique on a carbon-'Calite' column, and named the two components II₁ and II₂. Kestose, II₁ and II₂ are all trisaccharides. Samples of his compounds were examined electrophoretically, found to be homogeneous, and were later used as controls. II₁ does not appear to be separated in C, as the small difference in mobilities of II₁ and kestose would necessitate a considerably longer time of running, at the end of which the faster-moving components will have left the anode end of the strip.

In the earlier stages of the investigation it was assumed not only that II is homogeneous but that, judging by its paper chromatographic behaviour, it might be identical with component α_1 produced by mould invertase⁵. This would have provided a quicker route for the preparation of a large quantity of II₁ for the study of its structure. It could be shown, however, electrophoretically that the mobility of α_1 is distinct from that of II₁ and similar to that of II₂ (F). The fastest spot in A was found to correspond to the spot ahead of sucrose in C and to be a compound of fructose with glycerol, probably fructosyl-glycerol. This component had previously been observed⁶, and its formation depends on the presence of glycerol in the invertase preparation.

At the high voltage applied the electro-osmotic effect is considerable, as shown in F, counteracting the migration of the sugar-borate complexes towards the anode and making them appear to travel towards the opposite electrode. This effect might to some extent interfere with the determination of true values of mobilities, but apparently does not obstruct the reproducibility of the separations. Whatman No. 3MM paper was found in this case to give the best results with regard to loading capacity and regularity of spots. Although the thicker paper meant higher current values, the cooling system proved to be adequate in dealing with an energy dissipation of 60 watts. With more efficient cooling the final current value was recently limited to 25 m.a.m.p.

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Thiaminase from Fresh-Water, Brackish-Water and Salt-Water Fish

It has already been reported¹ that there might exist in fish more than one enzyme possessing thiaminase activity. In view of this observation, it was thought of interest to investigate thiaminases from different varieties of fish.

For the present investigation, the fishes were classified into three broad groups: (i) fresh-water fish; (ii) brackish-water fish; and (iii) salt-water fish. The following varieties (two from each group) were studied.

Source	Name of fish
1. Fresh-water fish	Khavale (<i>Barbus varanus</i>) (<i>Labeo bagrus</i>) (Sykes)
2. Brackish-water fish	Vamahl (<i>Mugil</i> sp.) Tol (<i>Hemichromis ornithopterus</i>)
3. Salt-water fish	Mandoli (<i>Ostrea edulis</i>) Pedve (<i>Sardinella tibrata</i>)

The whole fish was ground in a mortar and the enzyme extracted with water. The extracts were filtered and the filtrates were tested for activity. The effect of hydrogen ion concentration on the inactivation of thiamine by thiaminases from different varieties of fish was studied. The experiments were carried out between pH 3.0 and 7.0, using acetate and phosphate buffers respectively. The reaction mixture consisted of 5 ml. of water extract plus 5 ml. of the buffer and 25 µgm. of thiamine. The reaction mixture was incubated overnight for 16 hr. at room temperature (28° C.) with toluene as a preservative. Thiamine left over at the end of this period was estimated by the thiochrome method². The results of typical experiments are shown in Fig. 1. Although six species of fish were examined for thiaminase activity only three are represented graphically for the sake of convenience. The other three species also showed a similar pattern of pH activity relationship.

It is evident from the above results that the fresh-water fish contains thiaminase having optimum activity only at pH 7.0 or above. The graph shows that the fresh-water fish contains only one enzyme exhibiting thiaminase activity. These results are in full agreement with those reported by earlier workers. While working with a carp, which is a fresh-water fish, Woolley *et al.*³ reported optimum activity at

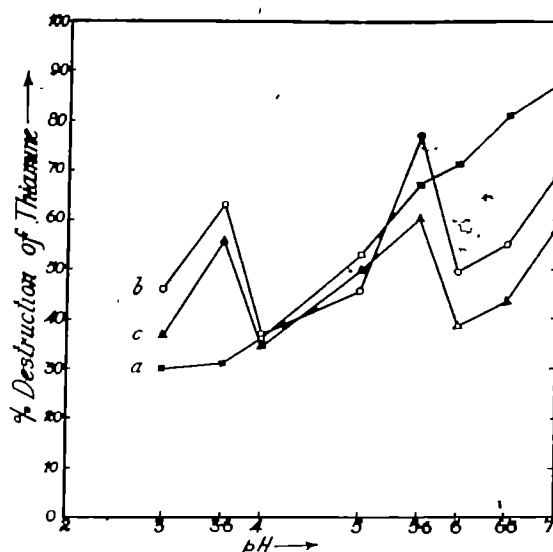


Fig. 1. Effect of pH on thiaminase from fish: (a) *Barbus varanus*, fresh-water fish, (b) *Mugil* sp., brackish-water fish, (c) *Ostrea edulis*, salt-water fish

pH 8.0, Sealock *et al.*⁴ at pH 9.1 and Bhagwat *et al.*⁵ at pH 6.0.

The curves for brackish-water fish and salt-water fish closely resemble each other, but vary remarkably from that obtained for the fresh-water fish. In the case of brackish- and salt-water fish, there are three different hydrogen ion concentrations (namely, pH 3.6, 5.6 and 7.0) at which the enzyme exhibits optimum activity. This confirms our previous observation¹. From the above results it appears that there are at least two thiaminases having optimum activity: (i) in the neutral or slightly alkaline range; and (ii) in the acid range. This difference may be due to the composition of the water and other environmental factors.

Extracts from all the three different varieties of fish were dialysed, and it was observed that the enzymes having optimum activity at pH 3.6, 5.6 and 7.0 from brackish- and salt-water fish and the enzyme from the fresh-water variety lost the greater part of their activity. The activity, however, could be restored in all cases by the addition of boiled original extract, thus confirming the presence of a coenzyme in all cases, as reported in a review article by Yudkin⁶.

The effect of the addition of certain metallic salts, namely, sulphates of copper, zinc, manganese, magnesium, iron, cobalt and nickel (*M*/100 concentration) to the dialysed extract was studied, and it was found that only manganese and cobalt salts could restore the activity of the enzyme exhibiting optimum activity at pH 3.6 and 5.6. None of these salts could, however, restore the activity of the enzyme exhibiting optimum activity at pH 7.0 from brackish- and salt-water fish, or that of the enzyme from fresh-water fish. This confirms our previous observation that the enzyme having optimum activity at pH 7.0 is altogether different from those having optimum activity at pH 3.6 and 5.6.

Fractional precipitation with organic solvents such as acetone, alcohol and dioxan failed to separate the three thiaminases; all three could be precipitated at 50 per cent saturation of ammonium sulphate. Adsorption-elution procedures were tried with a

number of adsorbents. All the thiaminases are adsorbed on fuller's earth, alumina C γ and bentonite. A number of solvents were tried, but none of them could selectively separate the three enzymes. Work on the separation of the three enzymes by paper chromatography is in progress.

We wish to thank the Indian Council of Medical Research, New Delhi, for the award of a research fellowship to one of us (S. T. D.) and to the Director of Fisheries, Government of Bombay, for identifying the fish.

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Free Amino-Acids in the Yolk during the Development of the Chick

THE progressive appearance of free amino-acids in the yolk during the development of the chick have been examined by paper chromatography, and we have observed that the density of the spots, from comparable aliquots, of yolks from fertilized hen's eggs increased from the fourth to the tenth day and decreased after this to the twelfth. To test these observations by an additional approach, similar samples were chromatographed on 'Dowex' and the results are reported here.

Whole yolks of fertilized hen's eggs at the stages of embryonic development indicated were precipitated with a solution containing 2 ml. of 1.0 N hydrochloric acid per 100 ml. acetone. For each yolk approximately 150 ml. of acetone was added. The water in the yolk made this aqueous acetone approximately 80 per cent acetone. The extracts were evaporated at 25°C. under moving air. The dried residues were dissolved in known amounts of citrate buffer, pH 3.4, and, after centrifugation, aliquots representing approximately 10 gm. of yolk were chromatographed on 100 cm. and 15 cm. 'Dowex' columns¹. Proline was introduced into some extracts in order to relate other chromatographic positions with the increased absorption at

Table 1. FREE AMINO-ACIDS IN THE YOLK OF THE FERTILIZED HEN'S EGG AT SEVERAL STAGES OF EMBRYONIC GROWTH

Amino-acid	8	Days of incubation 6 (μ M per aliquot*)	9	12
Threonine	—	0.65	3.0	0.91
Serine	0.35	1.9	5.0	1.8
Glutamic	0.22	0.46	3.2	0.79
Proline	—	1.6	6.8	0.40
Glycine	—	0.41	4.4	—
Alanine	—	0.61	3.7	0.71
Cystine	—	0.56	0.99	0.75
Valine	—	0.51	1.3	1.1
Isoleucine	1.1	1.9	2.7	0.92
Leucine	2.2	2.0	4.0	1.0
Tyrosine phenylalanine	2.3	1.3	5.3	1.3
Lysine†	0.67	0.69	2	1.0
Arginine†	—	—	1.5	—
Methionine	0.10	0.20	0.20	—

* Each aliquot represents the free amino-acids from 10 gm. yolk.
† Released from 15-cm. 'Dowex' columns

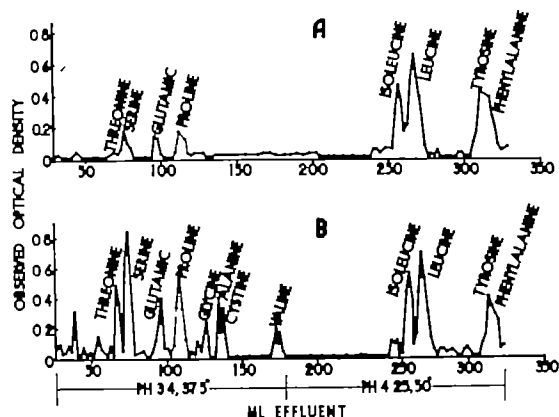


Fig. 1. Chromatographic separation of the amino-acids quantitatively released from 100-cm. columns of 'Dowex 50' with buffered solvents. A and B represent samples of yolks from fertilized eggs incubated three and six days respectively. Dotted lines indicate measurements at 420 m μ . 60 per cent of the peak shown for proline in B was due to introduced proline (see text). Methionine (unlabelled) is on left of isoleucine. The temperature on these columns was at all times less than 75°, and therefore the emergence of tyrosine and phenylalanine together in the effluent is not a limitation of the published procedure (ref. 1).

420 m μ that characterized the reaction product when this amino-acid is treated with ninhydrin. The paper chromatography followed the procedure of Levy and Chung². Acids were identified by relating the chromatographic positions of known acids with those of the unknown acids, and by comparing the effluent acids from aliquots of the extracts examined on 'Dowex' columns with the distribution of the amino-acids on paper from the corresponding sample.

Typical chromatograms are shown in Fig. 1. The free amino-acids (Table 1) increase to the ninth day, but decrease on the twelfth day. Presumably these changes are related to the progressive proteolysis of the yolks, an observation not previously described for the yolk³ of the hen's egg, although it is known to contain three proteinases⁴. The absence of fixed relative quantities of amino-acids characterizing the intervals sampled is interesting. Similar observations were made on the basis of the density of the spots on paper chromatograms of samples of yolks from the fourth to the twelfth day. It is unlikely that the relative concentration of amino-acids appearing on the ninth, as contrasted with the twelfth, day are a function of proteolysis alone. Such changes are doubtless related to the demands in protein synthesis during the development of the chick.

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Waste of Carbon and of Energy in Nitrogen Excretion

It is commonly accepted that, in nitrogen excretion, urea—and more especially uric acid—are wasteful to the organism in that they involve the loss of carbon and, moreover, chemical energy (see, for example, Needham¹). Compared with ammonia, these substances are regarded as inefficient and as only resorted to under the exigencies of water conservation. Table 1 summarizes data from the literature, from which it is seen that, per nitrogen atom, the order of carbon waste (column c) is:

ammonia < urea < uric acid (or 0; 0.5; 1.25).

But the amounts involved are scarcely significant; for example, for a man to excrete 30 gm. urea plus 0.7 gm. uric acid per day (Starling²) means the loss of 6.25 gm. carbon, which can be made up by the intake of 15.6 gm. glucose or equivalent. Similar calculations may be made for other non-ammonotelic animals.

In considering the energy factor, Needham quotes heat of combustion values for these three nitrogenous compounds in kcal./mole (column d), where the waste is in the order:

ammonia < urea < uric acid (or 1:1.69:5.11);

but it will be more pertinent to examine the figures for kcal./mole/nitrogen atom (column e), in which case the heat of combustion values appear in the order:

urea < ammonia < uric acid (or 1:1.18:1.51).

However, it may be considered that the free energy of formation gives a truer indication of the energy relationships to the organism, and the order for these values is:

ammonia < urea < uric acid (or 1:7.73:14.52),

when calculated as kcal./mole (column f), and

ammonia < uric acid < urea (or 1:3.63:3.87),

when calculated as kcal./mole/nitrogen atom (column g).

Table 1

	a	b	c	d*	e	f†	g
		Empirical formula	Ratio C/N	— ΔH Heat of combustion (kcal./mole)	Heat of combustion (kcal./mole/N atom)	— ΔG Free energy of formation (kcal./mole)	Free energy of formation (kcal./mole/N atom)
Ammonia		NH ₃	—	90	90	6.3	6.3
Urea		CO(NH ₂) ₂	0.5	163	76	48.7	24.4
Uric acid		C ₅ H ₄ N ₄ O ₆	1.25	460	115	91.46	23.87

* The figures in column d are given in Needham as cal./mole, but they should obviously read kcal./mole.

† The figures in column f refer to the aqueous state for ammonia (Partington, ref. 3) and for urea (Parks and Huffman, ref. 4); the figure for uric acid is for the solid state (Partington), and in view of the low solubility in water the figure for the aqueous state will be slightly reduced.

Thus it may be concluded that: (i) ammonia is the most advantageous from the point of view of economy in carbon and in energy (except slightly in — ΔH calculated per nitrogen atom); (ii) urea wastes less carbon than does uric acid, but the amount is unlikely to be significant in either case; (iii) urea is approximately as wasteful as uric acid, and both are somewhat more wasteful than ammonia, in terms of — ΔG calculated per nitrogen atom, but the waste of chemical energy is not nearly as great as is generally implied.

It is suggested that the question of which nitrogenous end-product is resorted to may still be con-

sidered as depending on the abundance of the water supply of the organism, but that urea and uric acid excretion are not as disadvantageous as is sometimes expressed in the literature. Any disadvantage in terms of carbon and energy waste is far outweighed by the advantages conferred by ureo- or urico-tely.

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Stimulation of Certain Bacteria by Raw Milk

ALTHOUGH raw milk contains bacteriostatic substances, certain concentrations of it actually stimulate some micro-organisms such as *Streptococcus agalactiae* and *Str. lactis*¹. Since the bacteriostatic properties appear fairly constant², variations in stimulatory properties may account for the observations of seasonal variation in the growth-rate of micro-organisms in milk³.

Using cows infected in one or more quarters of the udder with mastitis, it has been found that milk from infected quarters is more stimulatory to *Str. agalactiae* than milk from non-infected quarters of the same udder.

Colostrum taken just before cows calved had a very high stimulatory effect, whereas just after calving the effect was much less. This is interesting, as it is known that cows are more susceptible to mastitis during the dry period.

A range of amino-acids and growth-factors was examined to discover whether any had stimulatory properties like those of raw milk. Only certain sulphur compounds gave positive results. Sodium sulphide and thioglycollic acid were stimulatory at concentrations down to $10^{-3} M$; cystine and cysteine were still effective at $10^{-4} M$. Sodium sulphate was without effect.

It is suggested, therefore, that the concentration of certain sulphur compounds normally present in traces in milk affects markedly the rate of growth of some micro-organisms. The same factor may also control the susceptibility of cows to mastitis.

This work, which was carried out during the tenure of a British Council Scholarship at the National Institute for Research in Dairying, was part of an investigation on the inhibitory and stimulatory properties of milk.

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Separation of Pigment Cells of Cacao

THE purple pigment in the cotyledons of unfermented Forastero cacao is distributed in separate cells which are readily seen in cut sections. These separate cells can also be seen in sections from the Pale Criollo cacaos, though they are not coloured purple.

During the fermentation process, the contents of these cells dissolve, and diffuse throughout the cotyledons and into the testa of the bean. Some constituents of the substance of the cells undergo oxidative and other changes, and some of the material is lost into the 'sweetings' which drain from the fermenting beans.

When the freshly harvested beans are dried rapidly, there is no diffusion of the substance of the pigment cells, which can be seen apparently intact in sections of the cotyledons of beans dried in this way. These dried pigment cells have a higher density than the other cells of the tissue, and a separation of them has been effected as follows.

The dried beans are freed from testa and radicle, the cotyledons crushed to a suitable degree—a household coffee mill with the finest setting has been found suitable—and the ground mass suspended in petrol. The fat is dissolved, and of the mixture of insoluble suspended matter, the protein and starch are almost completely removed by sedimentation and decantation. The heavier mixture of free pigment cells and coarse tissue, mainly cellulose, is then sifted through a 240-mesh sieve suspended in petrol. The coarse, less dense, tissue is held on the sieve and is rejected; the free pigment cells pass through the sieve. Further careful sedimentation and decantation, preferably from a shallow dish, give a final product of separated pigment cells with about 5 per cent of adherent extraneous matter which is not removed by further washing with petrol.

The whole amount of the pigment cells in the cotyledons is not recovered in this way; some cells are too firmly attached to the lighter tissue and do not pass through the fine sieve. When carefully dried beans are used, about one-half of the total can be recovered as separated cells.

These dried pigment cells are dark purple, almost black, in the case of West African Amelonado cacao, somewhat lighter and redder purple in the case of most West Indian and South American cacaos, and a light puce colour in the case of East Indian and other 'white' Criollo cacaos.

The pigment cells are rather larger than the other cells of the dried cotyledons, the maximum lengths being about 50μ and $35\text{--}40\mu$ respectively.

It has been found that the whole of the purin substances, and probably the whole of the polyphenolic substances, in the cotyledons are concentrated in these pigment cells. They dissolve almost completely in water, giving a solution of pH 6.5–6.7, the same as that recorded for an aqueous extract of the fresh whole cotyledons¹.

The proportion of pigment cells in the total tissue of the cotyledons has been determined from a comparison of theobromine contents, and found to vary from 11 to 13 per cent by weight in the air-dry cotyledons. This compares well with the figure of about 10 per cent by count quoted by Knapp².

This separation of the polyphenolic and purin constituents from the other components of the bean provides a new and better approach to the study of these constituents, particularly the polyphenols.

Solutions can be prepared which are free from extractives from other components of the bean, and are less labile than solutions from extracts of the whole cotyledon.

This is being applied, and analyses obtained giving comparisons between cacaos from different sources.

This work was carried out in the laboratories of Messrs. Rowntree and Co., Ltd., York, and is communicated by permission of the directors.

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¹ Whymper, *Chemistry of Industry*, 30, 507 (1933).

² Knapp, "Cacao Fermentation", 58 (John Bale, Sons and Curnow, 1937).

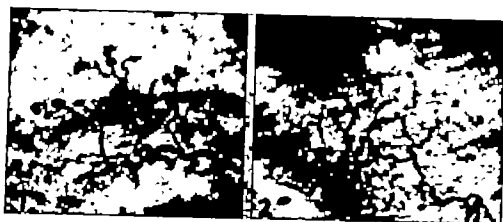
Intra-arterial Injection of Methylene Blue for Staining Nerve Endings in Striated Muscles

THE difficulty of staining nerve endings with methylene blue is well known. I have found that intra-arterial injection of methylene blue in an anesthetized animal consistently stained the nerve endings of striated muscles with greater uniformity than was possible by intravenous injection or the local infiltration of methylene blue. The method used is as follows.

Under ether anaesthesia, a convenient artery supplying the muscles the nerve endings of which are to be stained (for example, the femoral artery for staining the endings in the muscles of the hind-legs) is exposed and dissected free. The staining fluid consists of 0.25 per cent zinc-free methylene blue in a solution of 0.8 per cent sodium chloride, 0.2 per cent glucose, 0.02 per cent magnesium bromide, buffered to a pH of 6 with phosphate buffer¹, with 1 mgm. of hyaluronidase² added to 20 ml. of the solution immediately before use. The fluid is warmed to the body temperature and slowly injected into the exposed artery by means of a syringe and a needle of suitable size until the skin over the injected part turns deep blue in colour. The amount required for this depends, of course, on the dimension of the area to be injected, hence preliminary trials are usually necessary to find the right dose. In adult rats and chickens, injections of about 4 and 40 ml. respectively into the femoral artery stained the nerve endings in the hind-legs. The tendency at the beginning is to inject too little, but an overdose results in the undesirable staining of the blood cell and muscle nuclei or in the death of the animal.

After injection, arterial bleeding from the withdrawal of the needle is stopped by clamping the artery with artery forceps, and the animal is kept alive under anaesthesia for 10 min. before killing it by bleeding. The muscles are removed, the large muscles are sliced to about 3 mm. in thickness, and they are suspended on hooks in an oxygen chamber kept damp by a piece of wet cotton-wool. After about half an hour the 'blued' muscles are examined under the microscope and pieces that contain stained nerves and endings are selected for fixation overnight in chilled 8 per cent ammonium molybdate solution. Serial frozen sections are cut, rapidly dehydrated in chilled *n*-butyl alcohol, cleared in xylene and mounted in Canada balsam.

This method had been successfully used in staining the nerve endings of the leg muscles of rat, rabbit,



Two types of nerve endings in *M. extensor et adductor digitorum* of the second and third wing digits of the chicken, stained by the injection of methylene blue into the brachial artery. ($\times 800$)

frog and chicken (Figs. 1 and 2). The endings in the intercostal and diaphragmatic muscles of rats have also been demonstrated by retrograde injection through the carotid artery into the aorta.

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¹ Dens, W. A., *J. Path. Bact.*, **63**, 235 (1951).

² McGregor, I. A., *Nature*, **171**, 1070 (1953).

Conductivities of Polyelectrolyte Solutions at High Frequencies

THE electrical conductivity of aqueous solutions of electrolytes increases with increasing frequency of alternating current. For simple electrolytes such as potassium chloride, this increase in conductivity does not become apparent until the frequency is of the order of 10 Mc./s.

The explanation of this phenomenon is given by the Debye-Hückel theory of electrolytes, that when the time of relaxation of the ionic atmosphere is greater than the period of the alternating current used, then an increase in conductivity of the solution will occur. It was found, when experiments were being carried out on aqueous solutions of the polyelectrolyte sodium polymethacrylate, that an increase in conductivity occurred at a much lower frequency than with the corresponding concentration of potassium chloride solution.

If we consider an assembly of uncoiled long-chain polyions in an alternating electric field, the effect of the latter will be to cause displacements of the polyions or segments of polyions within their cylindrical ionic atmospheres. The rate of recovery from displacements in the direction of the axis will be relatively slow, since the ionic atmosphere will retain its cylindrical symmetry, and the restoring force will therefore be small.

As regards displacements resolved at right angles to the axis of the polyion, one would expect the time of relaxation to be similar to that of a small spherical ion. The summation of the various displacements should clearly result in the appearance of a frequency effect at a lower frequency than is observed with small spherical ions.

The apparatus for proving that the effect occurred consisted of a variable-frequency oscillator giving a constant voltage output. The current was passed through the conductivity cell, which was in series with a variable resistance, and a high-frequency milliammeter. At a particular frequency, if the conductivity decreased, then the series resistance could be varied until the same ampere reading on the high-

frequency milliammeter was noted. The adjusted reading on the variable resistance gave an indication of whether or not an increase in conductivity had occurred.

The readings from the instrument for the sodium polymethacrylate solutions were compared with standard potassium chloride solution, keeping all the conditions in both experiments identical, so that any stray capacitance effects were the same in both sets of solutions. This showed that the conductivity of sodium polymethacrylate solutions began to increase at a much lower frequency, that is, at about 0.1 Mc./s.

We wish to thank Mr. J. Rawcliffe and the Electrical Engineering Department of the College of Technology, Manchester, for technical advice while carrying out this work.

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Thermal Conductivity Measurements on Inert Media using Internal Calorimetry

INTERNAL calorimetry¹, developed for the measurement of blood flow, is basically a method for thermal conductivity determination. It uses a fine-gauge heated thermocouple embedded in the organ or medium under examination. In simple media a steady heating current applied to the filament raises the temperature recorded by the thermocouple. Temperature equilibration is rapid. Heat exchanges² are governed by Carslaw's equation³: $I^2 R = 4\pi r \theta k$, where k is the thermal conductivity of the medium, I the heating current, R the resistance of the heater, r the radius of a thermodynamically equivalent sphere and θ the temperature increment. Thus the relation between I^2 and θ is linear when k is constant; $4\pi r/R$ is a constant for any given recorder and constitutes its standardization factor (F), the experimental determination of which has been fully described elsewhere⁴.

The accuracy of the method was tested using various media. All determinations were carried out in a temperature-controlled room ($20^\circ \pm 1^\circ \text{C}$), with the medium in a water-bath at 20°C . In each case the relation between I^2 and θ was plotted from 0° to 3°C . at intervals of 0.2°deg . Knowing F , the thermal conductivity, k , was readily determined. The accuracy with solids and semi-solids was good, but was greatly reduced in liquids. The following values represent an average of three separate determinations, and are compared with figures quoted in the "International Critical Tables".

Substance	k (observed)	k (I.C.T.)
'Vaseline' (at 0°C)	4.55×10^{-4}	4.40×10^{-4}
Paraffin wax (m.p. 50°C)	6.45×10^{-4}	6.0×10^{-4}
Liquid paraffin	3.56×10^{-4}	$3.11 - 4.54 \times 10^{-4}$
Glycerol	6.72×10^{-4}	$6.58 - 7.41 \times 10^{-4}$
Water	13.6×10^{-4}	$13.86 - 14.23 \times 10^{-4}$

To accelerate equilibration it was usual to overheat the filament, then cool to the required temperature increment. In most media, equilibrium, once reached, was thereafter maintained indefinitely.

In 'Vaseline', however, it was found that about 20 sec. after cooling to the appropriate temperature a slow upward temperature drift began. Experiments were therefore carried out in which a steady current (such as would theoretically raise the temperature of the heater by 1 deg.) was suddenly applied to the recorder*. In 5 per cent gelatin gel, liquid paraffin, paraffin wax and glycerol no further temperature drift occurred after the calculated 1 deg. increment had taken place, but in 'Vaseline' the upward drift continued during the whole period of recording. In one experiment the temperature rose steadily during 30 min. to a value of 1.78 deg. higher than the theoretical equilibrium.

Read and Lloyd⁶ showed that a marked drop in thermal conductivity in tri-nitro-toluene occurred at or near the melting point. It seemed possible that a similar alteration in the thermal conductivity of some of the hydrocarbon components melting at 20–21° C. might explain the present findings. 'Vaseline' was stored in a refrigerator for a week, when its temperature was 4° C.; this temperature was probably lower than the melting point of any of the components. With the 'Vaseline' in a freezing mixture a steady heating current was applied as before. No temperature drift now occurred; thermal equilibrium was rapidly reached and maintained throughout the recording period.

These experiments emphasize the suitability of internal calorimetry for measuring thermal conductivity in non-fluid media. They also give fresh evidence suggestive of changes in thermal conductivity in a hydrocarbon mixture at about the melting point.

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* Grayson, J., *J. Physiol.*, 118, 54 (1953).

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² Carslaw, H. S., "The Mathematical Theory of the Conduction of Heat in Solids" (London: Macmillan and Co., Ltd., 1931).

³ Grayson, J., and Haigh, A. L., *J. Physiol.*, 120, 2P (1953).

⁴ Grayson, J., *J. Physiol.*, 118, 60 (1953).

⁵ Read, J. H., and Lloyd, D. M. G., *Trans. Farad. Soc.*, 44, 721 (1948).

Energy Requirements for Ion Transport in Steady-State Systems

SEVERAL investigators^{1–3} have attempted to calculate the energy required to maintain steady-state exchanges of ions between animal tissues and their environments. Thus, Krebs, Eggleston and Turner¹ concluded that about 2.5 per cent of the respiratory energy was required for potassium exchange in brain cortex slices at 40° C., and Bernstein² calculated that the steady-state exchanges of sodium and potassium in red blood cells at 37° C. may require up to one-third of the free energy from glycolysis. These calculations^{1,2} were based on the assumptions that there was 100 per cent efficiency in the utilization of metabolic energy for ion transport, that the losses and gains of the same ion were independent, and that the movements of different ions were also independent of one another. These assumptions are not necessarily valid.

The value obtained for the free energy change in the net transport of 1 mole of ion from one electrochemical potential to another represents the minimum

energy requirement in a biological system. If some of the potentially available energy is not used in doing useful work, then the actual energy requirement will be more than that calculated from thermodynamics. In addition, the exchanges of one ion for another of the same kind in a steady-state system may not require any expenditure of energy since no net transport occurs^{3–5}. This is the case in a Donnan system and an ion-exchange resin in equilibrium with an aqueous salt solution. Harris⁶ has, in fact, shown that part of the to-and-fro movements of sodium and potassium in red blood cells takes place without a supply of energy. The migrations of different ions may also be linked⁷. The figures given above, obtained by the application of kinetic data on steady-state exchanges to thermodynamic data for net transport, are therefore maximum values of minimum ones and may have no significance.

This method of calculation has been applied to results⁸ on the exchange of sodium and potassium in guinea pig kidney cortex slices in steady states *in vitro*. It leads to apparently reasonable conclusions for respiring tissue (see also Krebs and co-workers¹) but to impossible conclusions for tissue in anaerobic conditions. Thus, respiring slices at 37° C. would need about 6 per cent of the potentially available metabolic energy for the steady-state exchanges of sodium and potassium. Anaerobically the Q_{CO_2} (μ l./mgm. dry wt./hr.) was +2.3 at 37° C. and less than +0.1 at 0° C. The exchange-rates (μ moles/mgm. dry wt./hr.) between the intra- and extra-cellular fluids at the two temperatures were 3.6 and 3.1 for sodium and 0.9 and 0.5 for potassium respectively. The potassium concentration in the tissue was about five times that in the medium, and a similar ratio for sodium was about 0.6 at both temperatures. Even on the assumption that the whole of the carbon dioxide evolved was associated with reactions yielding the same energy as those in lactic acid production from glucose (cf. Bernstein²) these results mean that, on the basis of this method of calculation, the energy requirements for steady-state exchanges of sodium and potassium at 37° C. and 0° C. would be 180 per cent and 2,500 per cent respectively of that which is available. It is of interest that the rate of exchange of potassium between 'Zeo-Karb 225' (10–30 mesh) and 0.01 N potassium chloride in equilibrium with it was found to be 10–25 times greater than the rates in kidney slices, though, of course, no energy was supplied.

These results show that it is not possible to calculate energy requirements for steady-state exchanges of ions from kinetic and thermodynamic data without information on the mechanisms responsible for the exchange.

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¹ Krebs, H. A., Eggleston, L. V., and Turner, C., *Biochem. J.*, 43, 580 (1951).

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⁶ Harris, H. J., *Biochem. J.*, 54, xiv (1953).

⁷ Hodgkin, A. L., and Keynes, R. D., *J. Physiol.*, 120, 45P (1953).

⁸ Whittam, R., and Davies, R. E., *Biochem. J.*, 54, vii (1953); 56, 445 (1954).

Vibrations as a Cause of Disintegration in Liquid Sheets

DURING photographic investigations into the disintegration of liquids by means of single-fluid pressure-atomizers, it was established that the liquid first forms a thin sheet which disintegrates well away from the mouth of the nozzle. The modes of disintegration of these sheets are influenced by the properties of the liquid, the nozzle, and the surrounding atmosphere. In certain circumstances, holes are formed in the sheet which are observed to expand rapidly as they travel away from the nozzle. This process is illustrated by a high-speed photograph of a sheet of mercury as it leaves a single-hole fan-spray nozzle (Fig. 1).

It has been established that holes in the sheet can be caused by the presence of non-wettable particles in the liquid or by certain turbulence characteristics in the nozzle, as expressed by an appropriate Reynolds's number. Investigations into the latter cause reveal a phenomenon which may give a clue to the flow mechanism in all types of nozzles traversed by compressible or incompressible fluids. Vibrations which give rise to the noise phenomenon in gaseous jets are thought to be set up by the flow of the gases through the nozzle. These periodic disturbances have for some time been the subject of observation, experiment and mathematical analysis. With liquid jets there is much evidence of turbulent, unsteady flow behind the nozzle being a primary cause of disintegration, but no experimental confirmation of periodic vibrations in liquid jets has yet been forthcoming.

Observations on sheets of liquid such as the above show random centres of disturbance which, as they travel away from the nozzle mouth, eventually break the film and result in holes. Fig. 2 shows a section of a sheet of mercury illuminated obliquely to disclose the disturbances on its surface.

A mathematical analysis of these random disturbances shows that their origin is inside the nozzle



Fig. 2

just behind the mouth, and that the frequency of the observed ripples in the sheet is of the order of 10 kc/s. Systematic work may reveal the cause of these disturbances and link them to possible vibrational phenomena inside the nozzle.

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High-Voltage Arcs in Argon-Nitrogen Mixtures

It has been known for some time that unusual discharges can be maintained in the gaseous filling (argon-nitrogen, 99.5 per cent, 0.5 per cent at about 600 mm. pressure) of commercial incandescent lamps¹. Recent studies of high-voltage arcs (1,000–2,000 V., 0–50 mamp., 60 c/s.) struck in the gaseous filling between the filament support leads of such lamps have been reported². When running the arc at low currents (0–5 mamp.), it appeared as a yellow-brown 'flame-like' glow, which had a distinct life-time of luminosity of the order of 1 sec. after the power had been switched off. As previously reported, the spectrum of this glow, photographed on Kodak I-N plates between 3500 and 9000 Å., showed only the following bands:

N₂ First positive system: (1,0), (2,1), (3,0), (3,1), (3,2) [(4,2), (5,3), faint]
N₂ Second positive system: (0,1), (0,2), (0,3), (0,4), (1,3), (1,4), (1,5)

This communication directs attention to probable excitation mechanisms involving vibrational levels of the $X^1\Sigma^+$ state of N₂, which now seem superior to those discussed previously³ in the explanation of this unusually low vibrational excitation of the $O^3\Pi_u$ and $B^3\Pi_g$ states of N₂ exhibited in this source.

The combined phenomena of unusually low vibrational excitation of the $O^3\Pi_u$ and $B^3\Pi_g$ states, and

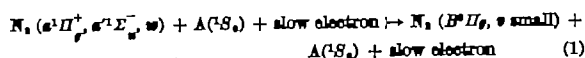


Fig. 1

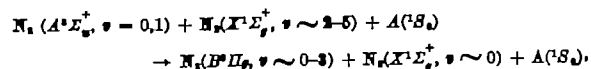
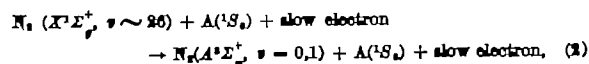
of an afterglow life-time of about 1 sec., strongly suggest that energy exchanges involving atoms and molecules in metastable states are taking place in the source. The available metastable states are: nitrogen, $\alpha^1\Pi^+$, $\alpha^1\Sigma^+$, ω , $A^1\Sigma^+$, $X^1\Sigma^+$ ($v > 0$); argon, ^3P . The vibrational levels of the ground-state $X^1\Sigma^+$ of N_2 , populated by emission of the Lyman-Birge-Hopfield and Birge-Hopfield systems, are metastable towards a radiative transition of electric dipole type to lower vibrational levels of the same state, as such transitions are 'forbidden' by a selection rule, N_2 being homonuclear. Thus nitrogen molecules in vibrationally excited levels of $X^1\Sigma^+$ have unusually long lives which will be terminated only by such processes as collision deactivation at the wall.

In the thermionically supported discharge plasma, some direct excitation of all atomic and molecular levels will be expected, but excitation of the singlet states of N_2 may be expected to predominate³. Subsequent radiation of the Birge-Hopfield and Lyman-Birge-Hopfield levels will, as explained above, cause levels of $X^1\Sigma^+$ to become populated up to $v = 26$.⁴ Recently computed values of vibrational transition probabilities of the Lyman-Birge-Hopfield system⁵ shows that levels $v = 2, 3, 4, 5$ of the $X^1\Sigma^+$ state will be populated preferentially in this way.

While the collision phenomenon (1)

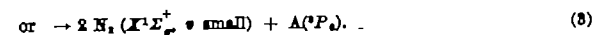
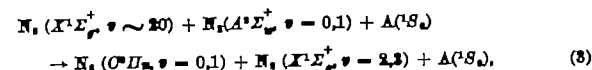


cannot be disregarded as a possible way in which the $B^3\Pi_g$ levels become populated, it seems reasonable to suppose that the reactions (2)



would also be probable in view of the close energy equalities exhibited throughout, and because of the long lives and expected abundances of the reactants on the left-hand sides of (2). Subsequent radiation of the (0,0), (1,0), (2,1), (2,0), (3,2), (3,1) bands of the first positive system is then predicted from recent computations of vibrational transition probabilities of this system⁶.

The preferential population of the $v = 0, 1$ levels of the $O^3\Pi_u$ state may be similarly explained in terms of mechanism (3):



The second alternative would occur if sufficient energy were available to excite levels of $O^3\Pi_u$ higher than $v = 1$. The metastable argon atoms taking part in the collision would then be preferentially excited. The observed bands of the second positive system (0,1), (0,2), (0,3), (0,4), (1,3), (1,4), (1,5) are those which would be predicted as most probably arising from the $v = 0, 1$ levels of the $O^3\Pi_u$ state from recent values of the vibrational transition probabilities of this system⁶.

Experimental work on these discharges is continuing.

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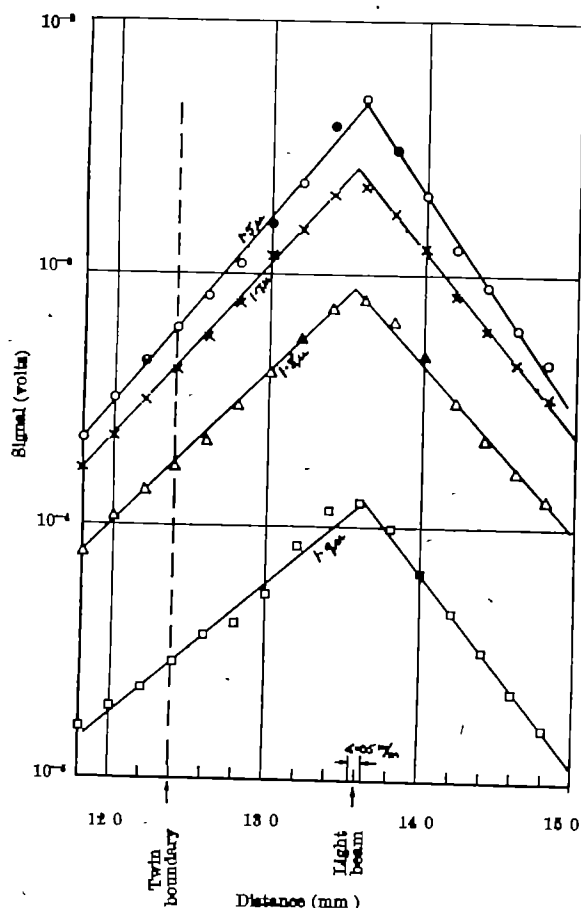
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Transmission of Electrons and Holes Across a Twin Boundary in Germanium

THE recently developed technique¹ of investigating the diffusion of minority carriers in an ambipolar semiconductor has been applied to the study of a twin boundary in germanium. Twinning about a (111) plane readily occurs in crystals having the diamond structure, such as germanium and silicon. A single crystal of n -type germanium, containing one twin boundary, was pulled from the melt by the Czochralski technique. The material used was of reasonably high purity, approximately 5 ohm-cm. resistivity at room temperature. A slice approximately 0.5 mm. thick was cut from this in such a manner that the twinning plane was perpendicular to the surface, which was then ground in the usual manner and etched in $CP.4$ ². The specimen was irradiated with a narrow beam (0.05 mm. wide) of chopped infra-red light, having a wave-length comparable with the width of the forbidden energy gap, 0.72 eV. A probe close to the illuminated spot picks up an electrical signal which corresponds to the change in the Fermi-level or the floating potential under the probe. This change in the potential is proportional to the local density of minority carriers excited across the energy gap by the absorption of the radiation. The drop in signal strength observed as the light spot is gradually moved away from the probe is due to the decay in the number of these carriers. In a single crystal, such decay is caused mainly by recombination of the excess carriers at trapping centres, and a logarithmic plot of signal strength versus distance should give a straight line, the slope of which determines the diffusion distance, closely related to carrier mobility and life-time.

If the texture is not perfect, a discontinuity in signal strength would be expected wherever the electrons meet some major defect in the structure, which would result in the setting up of a potential barrier. The measurements on the specimen described, which was apparently perfect apart from the twin boundary, are plotted in the accompanying figure; they show no discontinuity, the lines being in fact quite straight and of identical slope on either side of the probe, which was located 1.1 mm. away from the boundary. Apparently, electrons passed across this boundary just as freely as they moved in the crystal where they originated.³



The diffusion distances derived from these measurements are given below, together with the corresponding life-times, calculated on the assumption of $43 \text{ cm}^2 \text{ sec}^{-1}$ for the diffusion coefficient of holes. The somewhat lower value for 1.5μ is presumably due to the increased absorption of the radiation near the surface layer and the correspondingly higher rate of recombination there.

Wave-length (μ)	1.5	1.7	1.8	1.9
Diffusion distance (mm.)	0.54	0.63	0.66	0.66
Life-time (sec.)	68	92	98	103

As a further check on the transmission of holes across a twin boundary, transistor action was investigated on another similar crystal with an emitter point on one side of the twin boundary and a collector on the other. The two points were spaced about 0.2 mm. from either side of the boundary. Distinct transistor action was observed as readily as on any similar piece of single-crystal material.

It would therefore appear that, in contradistinction to grain boundaries, twin boundaries will not impede the transmission of free electrons or holes to any marked degree. This is not surprising, as the transmission from one twin to the other takes place across a single atomic layer; also, the energy involved in twinning is quite negligible compared with the main lattice energy. Electrons and holes can obviously bridge such a narrow region by the wave mechanical tunnel effect without any marked resistance.

It is suggested that similar techniques might, with advantage, be applied to the study of various faults

in the structure of solids, as, for example, to the boundary region between two grains which have been made to grow with certain specified orientations.

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¹ Haynes, J. R., and Shockley, W., *Phys. Rev.*, **75**, 691 (1949).

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Fatigue Strength of Pure Tin at Room Temperature

THE fatigue strengths of many tin alloys at both room and elevated temperatures have been reported¹, but I have found no figure for pure tin in the literature. Experiments have therefore been made to determine the fatigue strength of the pure metal in the cast condition. The measurements were made on a Wohler type machine with four-point loading, using a relatively thick specimen with a short gauge-length.

Tests were made up to 10^8 cycles of stress and these showed no evidence of a true fatigue limit. The fatigue strengths at 10^7 and 10^8 cycles of stress are 0.19 and 0.17 ton per square inch respectively.

It is of interest that the fractures produced by fatigue were wholly intercrystalline. After testing, the grain boundaries were revealed on the polished surface of the specimen, indicating that intergranular movement had taken place during the test. In addition, a general roughening of some grains indicated that transcrystalline deformation occurred at the same time, either on sub-boundaries or on slip planes.

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Graphite Lubrication in Grey Cast Iron

DURING work with the Lunn apparatus¹ on dry friction between a sliding tungsten carbide ball and a grey cast iron test-piece, two different types of tracks were obtained. The first type of track had a black appearance when examined with the naked eye or in the microscope, and a continuous film of deformed graphite covered the surface of the track. The L value of this film was high, which indicated good electric conductivity of the film. The second type of track had a bright, metallic appearance, and on examination with the microscope very small amounts of deformed graphite were observed. In this case, the L value was low, which indicated the build-up of an insulating film—even if the specific pressure is of the magnitude of $10,000\text{--}12,000 \text{ lb./sq. in.}$

The two types of tracks could be produced on the same test-piece, depending on the conditions under which the experiment was carried out. If conditions did not allow water vapour to be adsorbed to the cast iron surface, the first type of track was obtained. Adsorption of water vapour always resulted in a change to the second type of track.

These observations made on grey cast iron are in agreement with the experiments of Savage¹ on the lubricating effects of pure graphite.

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¹ *Trans. Danish Tech. Soc.*, No. 2 (1952); see abstract in *J. Inst. Metals*, 114 (Oct. 1953).

² *ASM*: "Mechanical Wear", 95 (1950).

Very Long Sequences of Geomagnetic Activity and Its Annual Variation

It is well known that moderate geomagnetic storms tend to recur after 27 days. Such storms are not related to sunspots, are almost always of gradual commencement type and are well marked only during two or three years immediately preceding the sunspot minima. A large number of such sequences, consisting of seven or eight storms, have been recorded; a few much longer sequences have been mentioned by Bartels¹. The longest sequence of which we are aware in the literature consisted of seventeen recurrences between December 9, 1929, and March 13, 1931.

We have studied the recurrence tendency of geomagnetic activity for the three-year period 1950-53. A plot of three-day running means of the international magnetic character figures *C* for this period indicates that sequences of magnetic activity last much longer than has been thought hitherto. Our study further indicates that, after exhibiting well-marked storm-like characteristics for about five to six recurrences, the activity diminishes to such proportions that it can no longer be identified with a storm. Very often this may be regarded as the end of a sequence. We find, however, that the activity, after remaining low for a few recurrences, again becomes appreciable and the continuity of the sequence is maintained.

During the three-year period under consideration two long sequences have been identified. These sequences will be called *A* and *B* respectively. In addition, there are a few short sequences corresponding to two or more 27-day rotations and a few individual peaks of considerable activity, the latter mostly associated with sudden commencement type of storms. The major part of the activity, however, is covered by the *A* and *B* sequences.

The *A* sequence which commenced with the moderate storm of July 11-12, 1950, has continued to date; the latest storm of this sequence as recorded at Kodaikanal commenced on September 19, 1953. The *B* sequence appears to have begun on November 21, 1951, and has also continued to date, the latest storm in the sequence having started on September 3, 1953. The total number of recurrences of the *A* sequence so far is 40, and that of the *B* sequence 21. Most of the time the magnetic activity for both the sequences has been pronounced after 27 days, but in a few cases the period between individual days of highest activity was 26 or 28, and only in a very few cases 25 or 29. The mean period between recurrences for each one of the sequences is found to be 27.05 days.

The activity on individual days when it was maximum during the recurrences has been plotted for the two sequences using the actual *C*-figures for the days concerned. The curves show a regular periodicity;

the activity associated with the *A* sequence shows maxima only once a year about September-October and minima about March-April, whereas for the *B* sequence the yearly maxima occur about March-April and minima about September-October. The yearly maximum of activity rather than six-monthly maximum (equinoctial) appears to throw some light on the causes of seasonal variation of magnetic activity. It has been known for a long time that the mean monthly geomagnetic activity shows maxima about March and September—months of vernal and autumnal equinoxes. Bartels¹, who studied the annual variation of geomagnetic activity for a period of fifty-nine years, 1872-1930, found equinoctial maxima of activity to exist for years of high and medium as well as low sunspot activity. However, since monthly means of all geomagnetic activity were used by him, it was not possible to say whether, corresponding to each individual *M*-region, the variation of geomagnetic activity had a six-monthly period or whether the period was twelve months, with some *M*-regions giving rise to maximum activity about March and others about September. From his harmonic dial method, Bartels concluded that only the semi-annual wave of geomagnetic activity was physically significant. The sequences *A* and *B* which, in our opinion, are associated with two *M*-regions, show a behaviour quite contradictory to the idea of semi-annual wave. This result could not have been conclusively obtained without the identification of very long sequences.

The heliographic latitude of the earth attains its maximum positive and negative values of 7.2° on September 7 and March 5 respectively. If we postulate that the intrinsic activity of an *M*-region responsible for geomagnetic activity remains nearly constant over a period of the order of a year, the following conclusions can be drawn from the geometry of the situation. (a) If an *M*-region is located at heliographic latitude greater than 7.2° north or south, there will be a single maximum of geomagnetic activity centred around September 7 or March 5, depending upon whether the *M*-region is in the northern or the southern solar hemisphere respectively, with the minimum occurring on the other date. (b) If the heliographic latitude of the *M*-region is less than 7.2° north or south, there will be two maxima of activity situated more or less symmetrically about September 7 or March 5, depending upon the hemisphere (north or south) in which the *M*-region is located. The displacement from these dates will depend upon the latitude of the *M*-region. (c) If the *M*-region is located on the solar equator, there will be two maxima, about December 8 and June 6.

From our study of the recurrent storms during the period 1950-53 we may conclude that:

(1) There were two principal long-lived *M*-regions separated in longitude by about 180° . These were responsible for two separate long series of magnetic storms.

(2) A single yearly maximum for each of the series indicates that these *M*-regions were located at heliographic latitudes greater than 7.2° . The mean period of recurrent geomagnetic activity of 27.05 days indicates their position at 7.5° heliographic latitude if judged from synodic rotation period of sunspots and 16° if considered from that of prominences.

(3) The characteristic annual variation of geomagnetic activity, which was mainly associated with solar *M*-regions during the three-year period considered here, is found to be due to the approach of the earth's projection on the solar disk towards the

zones of maximum solar activity. Incidentally, this explanation of the annual variation is in accord with that given by Cortie² from his studies of the geomagnetic activity associated with sunspots.

Details of the investigation reported here will be published elsewhere.

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¹ Bartels, J., *Terr. Mag.*, 27, 1 (1932).

² Cortie, A. L., *Mon. Not. Roy. Astro. Soc.*, 73, 52 (1912).

Size of Fragments resulting from Tidal Disintegration

THE size of tidal fragments of a body composed of rock or ice, according to Jeffreys¹, would exceed 200 km. Since primary tidal stresses are tensile, they would elongate the disrupted body in the direction toward the other body, thus producing a long axis in this direction and tearing the disrupted body into disks the thickness of which might be, as Jeffreys suggests, more than 200 km.

The effect of secondary tidal stresses is not included in Jeffreys's computations and, therefore, his conclusions are questionable for large bodies. Within Roche's limit, the gravity holding the body together is neutralized only in the direction of the long axis, but is unaffected at right angles thereto. That is, the pressure on the materials varies from zero at both ends of the long axis to approximately its original value midway between. In the central disks, the secondary stresses due to the weight of the material must be considered in addition to the tidal tension tearing the body apart. Other secondary stresses due to change in direction of primary tidal stresses are minor, and are not discussed.

For example, consider that a body of the size and density of the earth is being disrupted by a tidal encounter, and that its surface rocks have a density of 3 gm./cm.³ with an ultimate crushing strength of 2,000 kgm./cm.². In the central disks the ultimate crushing strength of the rock would be reached at a depth of 6.7 km. below the surface. Below this level the rocks would fail by compression and shear, the materials of the disks would bulge into the widening rifts, and spalls and other fragments would fall into these rifts. Meanwhile, fragments less than a kilometre in size from above the 6.7-km. level would be broken off by tension, for the tensile strength of rock is less than 0.1 its compressive strength. Wherever the compression stresses exceed the ultimate strength of the rock, much of the rock would be crushed into small pieces, of which many would be as small as sand. Pieces falling into the rifts would be broken by impact.

Thus it seems possible that the combination of primary tidal tension and secondary stresses of compression, shear and tension would be competent to produce fragments much smaller than the 200-km. minimum computed by Jeffreys.

In the case of tidal disruption of smaller bodies, the size of fragments would vary approximately inversely as their acceleration of gravity; but even if the disrupted body were only a few hundred kilo-

metres in diameter, it would still be possible that secondary stresses would produce many small fragments.

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¹ *Mon. Not. Roy. Astro. Soc.*, 107, 260 (1947).

Processes controlling Zygomorph Formation and Zygotropism in *Mucor mucedo* Brefeld

ASPECTS of the process of conjugation in *Mucoraceae* have recently been discussed by Raper¹, Goodwin², Hawker³ and Catcheside⁴. In view of current interest in sexual processes in the *Thallophytes* the following incomplete results are presented.

Burgeff⁵ believed that zygomorph formation in *Mucor mucedo* was sometimes induced by an air-borne volatile substance or substances; he and Köhler⁶ also produced evidence for a water-soluble hormone which acted similarly after diffusing through the substrate. I have grown strains of *M. mucedo* from Basen (showing no spontaneous zygomorph formation) in a closed-ring system through which air was constantly recirculated while slowly exchanging with the outside atmosphere. Colonies, (+) and (−) in an alternating linear series on small separate blocks of agar, did not form zygomorphs when separated by 3-mm. air gaps; when they were separated only by sheets of permeable 'Celloidin' (which remained unpenetrated by hyphae) zygomorphs arose in the contact zones. There does not appear to be any strong evidence for air-borne induction of zygomorph formation. Several workers have obtained evidence for the existence of diffusing hormones in the substrate, but no active extract or metabolite fluid has been isolated.

Two methods have given inconclusive but promising results. In the first, liquid decanted from mixed (+) and (−) mycelia growing submerged in aerated 2 per cent malt extract solution, filtered, and concentrated by partial freezing and removal of ice, was tested by transferring to antibiotic assay cups placed about 3 mm. from the growing edge of (+) and (−) colonies. Occasionally in repeated tests local production of zygomorphs was observed in the (+) but not in the (−) colony. Malt solution alone treated as above had no effect. Recently, using a modification of Raper's cascade technique, distinct zygomorph formation (with no signs of copulation) was observed when 2 per cent malt extract solution having previously passed through (+) and then (−) mycelia reached a second (+) culture. This unfortunately gives no clear indication of the sequence of hormone production, but it is hoped that current work will provide an unequivocal answer on this point.

The next stage in the conjugation process, the zygotropic response, was studied using small blocks of agar cut transversely from the copulation zone between (+) and (−) colonies newly grown into contact in Petri dishes. There was thus a tuft of unmixed (+) zygomorphs at one end of the block, a mixed tangle with copulation in the middle, and (−) zygomorphs at the other end. Successive series of these blocks were then arranged by hand or micromanipulator so that zygomorphs of one type were brought near those of either the same or alternatively the opposite mating type, pointing in various directions, and at various distances. Repeated observations confirmed

the mutual positive response between (+) and (-) xygophores. Further, a mutual aversion between xygophores of the same mating type was discovered; that is, (+) xygophores are repelled by (+), and (-) by (-). The attraction has been detected over a distance of 2 mm., the repulsion over 1 mm. Neither effect was shown when the xygophores on one side of the gap were replaced by vegetative mycelium of either mating type bearing sporangiophores but no xygophores.

Vandendries and Brodie (see Buller⁷, and Langeron⁸) claimed that the repulsion, over distances of up to 3.5 mm., which they observed between certain haplonts of *Leontia betulina* was transmitted through thin air-tight barriers of glass, mica, celluloid and silver, and must be due not to a chemical stimulus but to radiations. I was unaware, until recently informed by Dr. J. H. Burnett, that this claim was later withdrawn by Vandendries⁹ in a little-known paper. In my experiments, when thin barriers (2-50 mgm./cm.²) of fused quartz, glass, mica or aluminium foil were erected between paired tufts of xygophores prepared as above, no attraction or repulsion was observed, nor was it when normal diffusion between xygophores was interrupted by a current of moist air from a micro-jet. Using mica or aluminium foil with a fine perforation as a barrier, attraction was manifested, (+) and (-) xygophores respectively curving from opposite sides and growing towards the pore even when the arrangement was such that no straight path existed between any xygophore on one side through the hole to one on the other side. These results indicate that xygotropism in *M. mucedo* is a form of chemotropism and not, as suggested by Köhler, a response to any electromagnetic radiation. It seems necessary to postulate two volatile substances, one evolved by (+) xygophores, stimulating elongation growth in (+) xygophores and retarding it in (-) xygophores, the other evolved by (-), stimulating (-) and retarding (+). A directional response could occur, since the frequency with which diffusing molecules of the active substance impinge on the near face of the xygophore is greater than on the side away from the source: estimates of the difference suggest values of the order of 0.1-0.5 per cent. This is of the same order as the estimated minimum difference in light-energy absorption required for phototropic curvature of *Phycomyces* sporangiophores under unequal bilateral illumination¹⁰, so a xygotropic curvature from such a minute difference is quite conceivable.

A more extensive account of these and other observations, with appropriate acknowledgments, is being submitted for publication in the *Journal of Experimental Botany*.

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⁴ Calchovide, D. G., "The Genetics of Micro-organisms" (London, 1951).

⁵ Burgeff, H., *Bot. Abh.*, 4 (1924).

⁶ Köhler, F., *Planta*, 23, 258 (1935).

⁷ Buller, A. H. B., "Researches on Fungi", (5), Chap. 1 (1933).

⁸ Langeron, M., and Vanhoussem, R., "Précis de Mycologie", Chaps. 4 and 9 (Paris, 1932).

⁹ Vandendries, R., *C.R. Acad. Sci., Paris*, 193, 193 (1934).

¹⁰ Banbury, G. H., *J. Exp. Bot.*, 3, 77 (1953).

Nematode-destroying Fungi In Agricultural Soils

IN view of the serious losses to crops caused by eelworms, and the possibility that their destruction by predacious fungi may be of potential value as a means of control, some knowledge of the natural occurrence of these fungi in arable soil is desirable. The results set out below are those of a survey carried out on forty-nine samples of soil from various parts of England. The samples were taken from arable land, much of which was infested with potato root eelworm or cereal root eelworm, and from glass-houses in Warwickshire in which tomatoes were the principal crop, and in many of which the potato root eelworm was causing damage.

For examination of the samples, a little soil was scattered on the bottoms of sterile Petri dishes, and maize-meal agar, cooled to about 40° C., was poured into the plates, the soil being slightly mixed with the agar by gentle tilting. The medium was approximately neutral in reaction, no adjustment of pH having been made. The plates were incubated at room temperature, and periodically examined for predacious fungi. In order to keep down the growth of moulds, a very weak infusion of maize-meal was used in making up the medium. Predacious fungi usually began to appear in about a fortnight after inoculation, feeding on the free-living eelworms that wandered out on to and into the agar. Each batch of plates was kept under observation for a minimum period of three months.

From the forty-nine samples that were examined, eighty-two records of nematode-attacking fungi were made, a list of which is given below; the numeral following the name of the fungus represents the number of samples in which it was found.

<i>Arthrobotrys dactyloides</i> Drechsler	4
<i>A. oligospora</i> Frey	21
<i>A. robusta</i> Duddington	2
<i>Arthrobotrys</i> spp.	2
<i>Dactyloctenium aegyptium</i> (Koe) Sacc.	2
<i>D. psychrophilum</i> Drechsler	-1
<i>Dactyloctenium bembicoides</i> Drechsler	1
<i>D. cocciniforme</i> Drechsler	1
<i>D. lobata</i> Duddington	1
<i>Dactyloctenium</i> or <i>Dactyloctenium</i> spp.	2
<i>Trichothecium mycelium</i> Duddington	3
<i>Acrostalagmus obovatus</i> Drechsler	5
* <i>Acrostalagmus</i> sp. 282, n.sp.	1
* <i>Haptoglossa heterospora</i> Drechsler	6
<i>Haptoglossa angulata</i> Lohde	1
<i>H. klugiana</i> Dixon	1
<i>Maria concolor</i> Drechsler	1
* <i>Nematotomus heterospora</i> Drechsler	2
* <i>N. pachysporus</i> Drechsler	1
<i>Mycelium</i> 186	18
Undescribed hyphomycetes	6
Total number of records	82
* First British record	

The fungus referred to as 'Mycelium 186' is very common in soil. It is clearly a member of the Zoopagaceae, having non-septate hyphae that capture nematodes by simple adhesion, no specialized organs of capture being formed. No reproductive bodies of any kind have been observed, nor has the fungus ever appeared in any other habitat save soil. A full description of this fungus will be published elsewhere. *Acrostalagmus* 282 is a hitherto undescribed species with clavate spores; it is here placed for convenience in *Acrostalagmus* Corda (*conu* Drechsler), but may ultimately have to be described as the type of a new genus, owing to the unsatisfactory taxonomic status of *Acrostalagmus*. The interesting fungus *Haptoglossa heterospora*, probably best placed in the Lagenidiales, has already been found in soil in Denmark by Shepherd (*in litt.*).

A consideration of the list brings out one or two interesting points. The commonest fungus is *Arthrobotrys oligospora* (21 records), which is not surprising in view of its widespread distribution in many kinds of habitat¹. Its great preponderance over all other species except 'Mycoelium 186' is, however, surprising. Easily the second commonest is 'Mycoelium 186' (18 records); as this fungus has been recorded only from soil, it would seem likely that it is a specialized soil species, and it is possible that its constant failure to produce spores when grown on agar media may be correlated with this. How it reproduces in its natural habitat is not known, but among other factors the disruption of soil by earthworms might perhaps be considered. Like *Arthrobotrys oligospora*, it outnumbers other fungi in the list to a surprising extent. *Arthrobotrys dactyloides*, capturing eelworms by means of constricting rings, appears to be more frequent in soil than elsewhere. It has been obtained in Great Britain from compost by Dixon (personal communication), but apart from its occurrence in soil it does not appear to be a common British species. It has also been observed in Danish soil by Shepherd (*in litt.*). *Trichothecium cystosporium* is fairly prominent, and this species has also been isolated from soil on a previous occasion². The other species in the list call for no particular comment, though the frequencies of the ubiquitous *Harposporium anguillulae* and *Acrostalagmus obovatus* may be noted. The preponderance of hyphomycetes capturing nematodes by means of adhesive networks is also interesting.

Attempts to correlate the presence or absence of particular fungi with soil factors such as pH, etc., yielded no results; but it is clear that many more soil samples will have to be examined before any such correlations, if present, can be expected to become apparent. Quantitative information on the distribution of predaceous fungi in soil is also badly needed; this work is now in hand, and it is hoped to make it the subject of a future communication.

I should like to express my thanks to Mr. F. G. W. Jones, School of Agriculture, Cambridge; to Mr. H. C. F. Newton, Miss O. M. G. Duthoit and Mr. H. J. Ward, of the National Agricultural Advisory Service, West Midland Province; and to Mr. M. Brook, of Boots Pure Drug Co., for their help in providing many of the soil samples on which this preliminary survey has been based. The work has been made possible by a grant from the Agricultural Research Council, to which my thanks are also due.

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¹ Duddington, C. L., *Trans. Brit. Mycol. Soc.*, **34**, 323 (1951).

² Duddington, C. L., *Trans. Brit. Mycol. Soc.*, **34**, 598 (1951).

Demonstration of a Diffusible Fruiting Factor in Myxobacteria

RUNYON¹ gave a demonstration of a diffusible factor inducing the formation of fruiting bodies in Myxamoebae. Attempts to demonstrate a similar factor in *Chondromyces* by Bonner² are inconclusive because they resulted in mechanical disturbance of the swarm and of the surface of the medium, which are sufficient, in my experience, to stimulate the formation of fruiting bodies (cf. also Stanier³).

A very striking demonstration of such a factor in myxobacteria was obtained by placing squares, about 2 cm. × 2 cm. × 4 mm., of non-nutrient agar over fruiting bodies of one strain of *Chondromyces axiginus* and two of *Myxococcus xanthus* grown on a killed suspension of *Aerobacter aerogenes* in non-nutrient agar. The upper surface of these agar squares was inoculated with suspensions of vegetative cells, grown on one-tenth strength routine nutrient agar, which supports their growth but does not permit formation of fruiting bodies. Great care was taken to avoid mechanical disturbance of the agar surface; and as controls similar inoculated squares were placed on uninoculated *A. aerogenes* suspension plates, and some squares covering fruiting bodies were left uninoculated.

After three days incubation at 28°C., profuse formation of fruiting bodies occurred in the vegetative cells placed over fruiting bodies of the same species, but not in the controls, or in those vegetative cells of *M. xanthus* which were placed over fruiting bodies of *Ch. axiginus* or vice versa. The two strains of *M. xanthus* were mutually stimulatory.

Fruiting bodies did not form immediately over those below, but were most profuse at the edges of the inoculum, that is, at the greatest concentration of vegetative cells. This appears to indicate that the factor is rapidly diffusible. Further, increased formation of fruiting bodies in the areas covered by the agar was found to occur both with inoculated and uninoculated squares, and was apparently due to the mere presence of the agar.

It has been suggested by Quahl⁴ that compatibility, as indicated by the coalescence of vegetative swarms in close proximity, might be employed as a means of definition of species in myxobacteria. However, it is my experience that otherwise identical swarms may fail to coalesce, and it may be that the mutual stimulus of the formation of fruiting bodies could be employed for species or type differentiation.

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¹ Runyon, H. H., *Collecting Nat.*, **17**, 88 (1942).

² Bonner, J. T., 'Morphogenesis' (Princeton, 1952).

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Delay of Chromosome Rejoining in *Vicia faba* Induced by Irradiation

I HAVE shown¹ that fractionation of X-ray dosage administered to seeds of *Vicia faba* soaked in water causes no decrease in the number of two-hit chromosomal aberrations. However, with additional soaking in the protective agent, 2,3-dimercapto-propanol (BAL), previous to irradiation, a decrease is achieved on dosage fractionation. In order to further the understanding of this phenomenon, the following dosage-intensity experiments were performed. A constant dosage of 600 r. of 250 kVp. X-rays was administered in 3-min., 1-hr., 2-hr. and 3-hr. periods. The numbers of ring and dicentric chromosomes in 300 metaphase plates of the X-1 root-tip division were scored at each intensity.

As can be seen from Fig. 1, in those seeds soaked in water alone, there is no significant difference in the number of aberrations produced by the highest

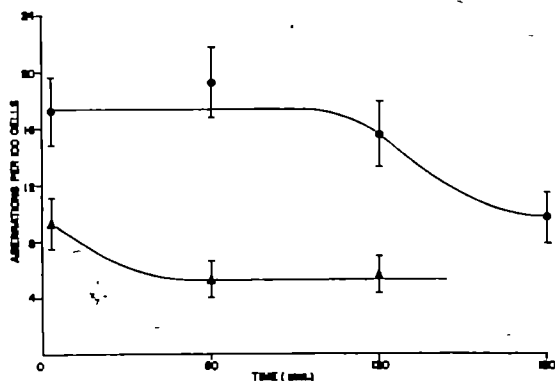


Fig. 1. Effect of intensity on chromosome aberrations. Upper curve, seeds soaked in water; lower curve, seeds soaked in 2,3-dimercapto-propanol

three intensities. Only when the dose is administered over a greater period of time than 2 hr. is there a decrease in the number of aberrations. This is easily explained if one assumes that no rejoining of broken chromosome ends occur within 2 hr. of the onset of radiation. However, if the seeds are pre-soaked for 1 hr. in a solution of $2 \times 10^{-3} M$ 2,3-dimercapto-propanol, there is a significant decrease in the number of two-hit aberrations as the intensity is decreased; evidently the 2-hr. lag period, during which little or no rejoining normally occurs, has been decreased. This effect of 2,3-dimercapto-propanol, a powerful antioxidant, strengthens the hypothesis that the major effect of apoxia is on the restitution of broken chromosomes^{1,2} rather than on the initial breakage³.

That the rings and dicentrics scored are authentic two-hit aberrations may be ascertained from the dosage curve in Fig. 2, which shows that the numbers of these aberrations increase as the square of the dose. This is contrary to previously published dosage curves⁴ on two-hit chromosome aberrations in the

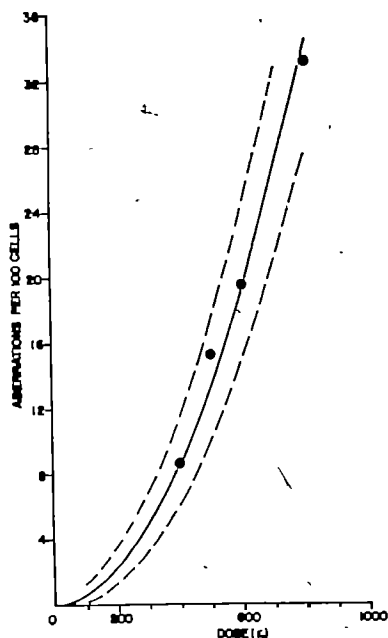


Fig. 2. Dosage curve of two-hit chromosome aberrations. Intensity, 200 r./mm. Dotted lines enclose 96 per cent confidence limits

seed of *Vicia faba*. This discrepancy is probably due to the fact that a large proportion of the anaphase bridges scored by others⁴ as two-hit aberrations are in reality the result of one-hit isochromatids.

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² Schwartz, D., *Proc. U.S. Nat. Acad. Sci.*, **38**, 400 (1952). Baker, W. E., and Von Halle, H. S., *Proc. U.S. Nat. Acad. Sci.*, **39**, 151 (1953).

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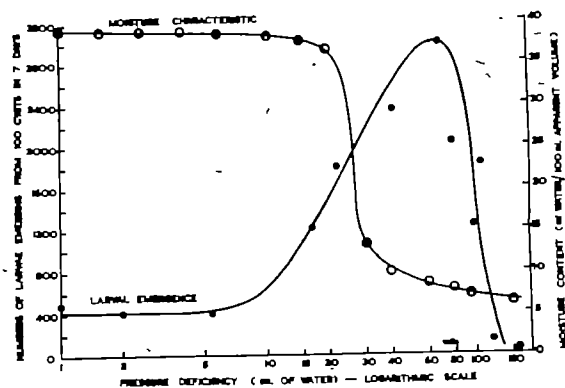
Hydrostatic Pressure-Deficiency and the Emergence of Larvae from Cysts of the Beet Elworm

LARVAE of the beet elworm (*Heterodera schachtii* Schmidt) are essentially water-inhabiting creatures, and their behaviour in the soil is governed by the properties of the soil water. The results of an investigation into the relationship between hydrostatic pressure-deficiency in an artificial soil composed of sand and water, and the number of larvae emerging from the elworm cysts, are summarized here.

One hundred cysts, mixed in 9 gm. of sand of particle-size 60–160 μ , were placed in each of a series of sintered glass funnels. Suction was then applied to the sand and water in each funnel to give a range of pressure-deficiencies. The apparatus was kept in a constant-temperature room at 24°C. ($\pm 0.5^\circ C$). The relationship between the logarithm of the pressure-deficiency (pF) and the numbers of larvae emerging is shown in Fig. 1.

A comparison of the curve for the moisture characteristic (that is, the curve of moisture content plotted against the logarithm of pressure-deficiency) with the curve for larval emergence and the logarithm of pressure-deficiency shows that a relatively low emergence occurs with 1–10 cm. pressure-deficiency when the sand is saturated. Maximum emergence corresponds to the pressure-deficiency at which the last pore space is emptied of water.

Other experiments have shown that larval emergence is dependent on oxygen concentration; at low oxygen concentrations (1–2 mgm. of oxygen per litre)



emergence is almost nil. It is suggested that the relatively low emergence occurring during 1-10 cm. pressure-deficiency is due to low oxygen concentration in the water around the cysts when the sand is saturated and the pore spaces are filled with water. An increase in emergence occurs after 10 cm. pressure-deficiency, when air appears in the pore spaces, resulting in increased oxygenation of the water film. Emergence rises to a maximum at 70 cm. pressure-deficiency, after which there is a decline. Two possible explanations of this decline are suggested. Egg hatch may be inhibited by the extraction of water from the cysts, and larval emergence may be impeded by the surface forces of the water film.

The effects of oxygen concentration, temperature, saturation deficiency, size of soil particles and different soil types on larval emergence are also being investigated.

I am indebted to the Sugar Beet Research and Education Committee for providing facilities for carrying out this investigation.

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Hardness of Arthropod Mouthparts

It is well known that many insects are able to bore through packing materials, including metal foils, used for wrapping foodstuffs and other commodities. During an attempt to develop a physical barrier that would be resistant to penetration by insects, the hardness of the mouthparts of a number of insect pests was determined.

Richards¹ considers the question of the hardness of arthropod cuticle, but it appears that no determinations have been made. In view of this, representatives of several insect orders and of other classes of arthropods were included in these tests.

Fresh materials were used in each case and the mouthparts, generally the mandibles, were removed and cemented to needles. Scratch tests were carried out on the minerals in Moh's scale of mineral hardness (see Lange²) which would appear to be the appropriate standard.

Determinations were made on species of the following genera:

Insecta
Coleoptera: *Tenebrioides*, *Rhizopertha*, *Stagobium*
Lepidoptera: *Pterolocusta*
Isoptera: *Mastoterms*
Orthoptera: *Calcaripr*
Crustacea
Decapoda: *Oherus*
Myriapoda
Chilopoda: *Scolopendra*
Arachnida
Scorpiones: *Carcophonus*
Arachnida: *Isope*

In each case the hardness was found to be approximately 3, the specimen of calcite being scratched with difficulty. Minerals softer than 3 were readily marked. In view of the function of mouthparts, this may represent the highest value to which arthropod cuticle can be hardened.

It is of interest to consider the role taken by calcification of the cuticle which occurs notably in the Crustacea. Many authors have examined the calcium salts involved, and it appears that calcium carbonate in the form of calcite is the usual deposit. Whatever properties calcification may modify, it is

clear from the present results that it will neither harden nor soften the cuticle.

From the above evidence there would appear to be no physical difficulty in insects boring through foils made from such common metals as lead, tin, copper, zinc and silver, providing that these have not been work-hardened.

I am indebted to Mr. A. Musgrave, of the Australian Museum, for identification of the Arachnida.

S. W. BAILLY

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Nov. 18.

¹ Richards, A. G., "The Integument of Arthropods" (Univ. Minnesota Press, 1951).

² Lange, N. A., "Handbook of Chemistry" (Sandusky, Ohio, 1941).

Effect of Refrigeration of the Pupae of *Microbracon brevicornis* Wesm. on the Pigmentation of the Adult

DURING the course of mass breeding of *Microbracon brevicornis* in the parasite laboratory of the Entomology Division of this Institute for the purpose of exporting them to the United States of America for the control of pink boll worm in the cotton belt of that country, it was necessary to maintain a stock of pupae of the parasite in cold storage at a temperature of $10 \pm 3^\circ \text{C}$. It was observed that the adults emerging from the chilled pupae which had been in cold storage from 10 to 75 days showed dark pigmentation ranging from dark grey to jet black, as against the distinctly brown individuals obtained from unchilled pupae.

The possible effect of humidity on the production of melanic forms was eliminated by subjecting the pupae to low ($10 \pm 3^\circ \text{C}$.) and high (25°C .) temperatures at different humidities. Irrespective of the humidity, the parasites that underwent metamorphosis under low temperature always showed darker pigmentation. Similarly, the effect of light on the pigmentation of the adults also showed that while dark forms emerged from chilled pupae, whether kept in darkness or in light, all adults that were obtained from pupae at higher temperatures under both conditions were brown individuals. It was thus concluded that low temperature alone was responsible for the abnormal pigmentation of adults obtained from the chilled pupae.

Kaestner¹ observed that when females of *Habrobracon* are exposed to extremes of heat or cold, the parasites became dark and the effect was transmitted apparently through the plasma to the next generation. However, in the present case it has been observed that the dark forms when bred at a temperature of 25°C . and 70 per cent humidity gave rise to normal brown individuals. Evidently in this case the progeny has failed to inherit the acquired character of their parents, and we are therefore unable to confirm Kaestner's observations. Genies, Schlottke and also Kuhn² have shown that, in the case of *Microbracon habitor*, at low temperatures the black pigments become dominant, whereas at higher temperatures the pigmentation is more reduced until finally entirely yellowish forms are produced. In the present case, even when the parasites were bred at 35° and 40°C ., they did not exhibit any loss of pigment-

ation. Genies and others have not connected low temperature with depressed metabolism in insects, which appears to be one of the probable causes for dark pigmentation.

The conclusion from these experiments is that pigmentation in this case is perhaps a physiological phenomenon caused by the inability of cells to dispose of the breakdown products of metabolism in chilled pupae at a low temperature; these products tend to increase and accumulate as the period of refrigeration is extended. This explanation supports the hypothesis put forward by Cordier³ that "the production of melanin is sometimes regarded as a mechanism for disposing of toxic phenols arising as breakdown products in metabolism".

Extending these findings to field-conditions, it will now be possible to explain the occurrence of seasonal forms of *M. brevicornis*. A source of confusion is the great variation in colour to which *M. brevicornis* is liable; it is evident that the difference in colour is almost valueless in defining species. The parasite over-winters in the pupal stage and therefore the adults emerging from the over-wintering pupae are dark in colour compared with the brown forms that emerge during the spring. This was confirmed by the specimens collected from cotton fields in northern India where, during the months of January and February, the field-temperature is very low. Hence it is possible that early workers in India, though they might have reared *M. brevicornis* from pink boll worm (*Platyedra gossypiella* Saunders), took it for granted that the parasite was *M. lefroyi* D. and G., and never recorded *M. brevicornis* as a potential parasite of pink boll worm.

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New Delhi 12.
Nov. 17.

¹ Kaestner, M., *Arch. Entw. Mech.*, 124, 1 (1931).

² Genies, P., *J.R. Soc. Biol.*, 86, 767, 1080 (1932). Schlotzke, M., *S. verp. Physiol.*, 3, 602 (1935). Kuhn, *Nachr. Ges. Wiss. Göttingen Math. Phys. Kl.*, 407, (4) (1937).

³ Cordier, R., *Ann. Bull. Soc. Roy. Sci. Med. Nat. Brum.*, 43 (1928).

Culture of Insect Tissues

IN recent years, in fact since the culture of vertebrate tissues became an accepted laboratory technique, insect physiologists have attempted to produce cultures of insect tissues. So far, they have not succeeded. All that has been achieved with insects is the maintenance of organs in a living state¹, sometimes with the continuation of metamorphic changes², or a limited growth of tissues still organically connected with the living body of the insect³. The literature also contains reports of insect-tissue culture which can be assigned to one of two classes: either growth has genuinely taken place during an experiment of extremely short duration⁴, or else what was probably a mere cell migration, such as I have found with *Rhodnius prolixus*, was recorded as growth⁵. The criterion of a tissue culture which is to compare with vertebrate tissue culture would seem to be the possibility of maintaining it by means of sub-cultures, over an extended period of time, and it is in this sense that previous efforts may be said to have failed.

Apart from the work of Luschar⁶, which in any event was not intended as a true *in vitro* cell culture, no attempts at tissue culture have been carried out on insects of the order Hemiptera-Heteroptera, of which *Rhodnius prolixus*, a useful and convenient laboratory insect, is a representative. It seemed to me that *R. prolixus* would be a very suitable insect for such experiments, since so much is already known about it. It has been found, for example, that the epidermis of *R. prolixus* will grow when implanted into the body cavity of another individual, whereas the other tissues degenerate⁶. The epidermis of this insect will also grow to a certain extent along glass tubes inserted into the cut ends of limbs⁷. The processes of wound repair in the living *R. prolixus* are well known⁸, and have been found to involve the proliferation of the epidermal nuclei.

In the experiments to be described here, fourth and fifth instar nymphs of *R. prolixus*, which had been fed four to seven days previously, were used. They were surface sterilized for five minutes in 0.1 per cent aqueous mercuric chloride, washed in three changes of sterile water, and then put into a sterile Petri dish lined with filter paper, where they remained until dry. Using a sterile technique, hanging drops of the insect's hemolymph were made, in which small snips of the abdominal cuticle and epidermis were suspended. Care was needed in order not to puncture the blood-laden stomach, and drops which were visibly contaminated with the stomach contents were discarded. Altogether, forty-eight sterile drops were prepared, and the proportion of losses due to bacterial infection was very small when mercuric chloride sterilization was used. Lysol (25 per cent) and methylated spirits were also tried as sterilizing agents, but had a deleterious effect on the insects, as shown by the failure of controls, sterilized but not dissected, to recover. It was found that bacterial infection was much more severe in drops made after the use of these latter sterilizing agents, and this suggests some ability of undamaged cells to cope with invading micro-organisms.

In a typical hanging drop, visible changes could be seen to occur, but unfortunately they can only be regarded as degenerative in nature. After the first twenty-four hours, a mass of vacuoles and chromatic granules flowed out from the edge of the cuticle, while the rest of the epidermis contracted towards the centre of the cuticular fragment. Hemolymph cells were numerous in the drops at first, but disappeared later. In three of the drops, there were many amoeboid hemolymph cells, which coalesced into compact groups, and remained for the duration of the experiment. Their nuclei stained apparently normally at the conclusion of the period of incubation. After 10-14 days incubation at 30° C., that is, a few days after visible changes had ceased, the preparations were fixed and stained. Many nuclei could be seen, but rather weakly stained, and no mitoses were visible.

A few trials were made with other parts of the anatomy of *R. prolixus*, such as heart, testis, muscle and fragments of unfed first instar bugs; with bacteriological broth instead of hemolymph as a medium; and with tissues of the cockroach *Blattella orientalis*. No success attended any of these variations.

There are two obvious developments of the methods here employed which occur to me and may be mentioned. The first is to replace glass surfaces by

mice, or cover them with a film of wax, and the second is, by analogy with vertebrate tissue culture, to enrich the culture medium with an extract of *R. prolixus* embryos. These developments have not been possible at present, and the brief account given here is for the benefit of those who may wish to follow this line. It is important to emphasize that, up to now, there is no indication whatever that insect tissues will form cultures of the sort familiar with vertebrate material.

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Nov. 19.

- ¹ Bagsh, H. A., *Trans. Roy. Soc. Trop. Med. Hyg.*, **48**, 225 (1949).
² Frow, J. G. H., *Brit. J. Exp. Biol.*, **6**, 1 (1953).
³ Lüscher, M., *Nature*, **160**, 878 (1947).
⁴ Carlson, J. G., *Biol. Bull. Woods Hole*, **60**, 100 (1946).
⁵ Gavrilov, W., and Cowey, S., *Ann. Parasit. Hum. Comp.*, Paris, **18**, 180 (1941).
⁶ Wigglesworth, V. B., *Quart. J. Micr. Sci.*, **79**, 91 (1936).
⁷ Wigglesworth, V. B., *J. Exp. Biol.*, **14**, 364 (1937).

Occurrence of *Puccinia polysora* Underwood in the Indian Ocean Area

THE maize rust fungus *Puccinia polysora* was first described in 1897 by Underwood in Alabama on *Tripsacum*, a plant allied to maize; it was later also found on *Eriophorum*, a species of grass related to the sugar-cane. In 1941, Cummins detected the fungus for the first time on maize in the United States, but a careful review of herbarium material collected earlier from different parts of the Continent and deposited as the common maize rust, *P. sorghi* Schw., brought out that many of the specimens had indeed been attacked by *P. polysora*.

The new rust, which does not apparently cause severe injury to maize in the New World, was until recently unknown in the Old; but in 1949 a severe outbreak of the disease was observed in Sierra Leone in West Africa. The following year, serious epidemics broke out in Liberia, Ivory Coast, Gold Coast, Dahomey, Togoland and Nigeria, resulting in food shortage among the native tribes. By the end of 1952, the disease had spread to Tanganyika, Uganda, Nyasaland and Kenya, and had reached the east coast of Africa.

In March 1953, the rust was detected in violent epidemic form at various widely separated places in Mauritius, and in May last I identified the disease in the neighbouring French island of Réunion, which I was visiting on a short mission.

In a letter dated September 29 last, the Director of the Phytopathological Laboratory of the Pasteur Institute of Tananarive informed me that he had newly identified the disease in certain districts along the east coast of Madagascar, the attack in one of the regions having been observed as from March 1953; but it was stated that there were no records of recent maize importations in Madagascar.

In Mauritius, legislation was promulgated in February 1951 prohibiting the importation of maize from the then affected West African areas and territories bordering them. Maize meal is, however, regularly introduced from Kenya by the military authorities for feeding the Askari soldiers stationed in the island since the Second World War; and washings from contaminated meal could account for

initial foci of infection in a new area. There does not, however, seem to be very strong reasons for considering that the disease was introduced into Mauritius in the Kenya consignments, unless it already existed in that country some time prior to its detection in 1952.

Réunion is about four hundred miles off the east coast of Madagascar and Mauritius one hundred miles farther eastward. Together with Rodrigues, four hundred miles still farther east of Mauritius, these two islands constitute the Mascarene Archipelago; but there is as yet no record of the presence of *P. polysora* in Rodrigues.

Both Mauritius and Réunion are linked with Madagascar and Africa by regular air services, while Mauritius is one of the fuelling points for Qantas aeroplanes on their route between South Africa and Australia via the Cocos Islands. The presence of *P. polysora* in Mauritius, which is the most easterly point it has yet reached, thus constitutes a menace both to Asia and Australia.

It has also been found in the United States and Canada that the spores of the cereal rusts can be carried in a viable condition by air currents to altitudes more than 15,000 ft. and to distances of several hundreds of miles from their point of origin. This means of spore distribution is now considered by some as possibly accounting for the present rapid spread of *P. polysora* in Africa. Its simultaneous discovery in 1953, for the first time, in Madagascar, Mauritius and Réunion would appear to support the hypothesis of spread by means of air currents.

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Nov. 25.

Geographical Distribution of Mating Types in *Gibberella cyanogena* (Desm.) Sacc.

Gibberella cyanogena, the ascomycetous stage of *Fusarium sambucinum* Fuekel f. 6 Wr., has been previously reported¹ to be bisexual (hermaphroditic) and self-sterile. In other words, single-ascospore and monoconidial cultures of this fungus belong to one or other of two mating types, designated m.t.¹ and m.t.², both of which may function as male and female but are self-sterile. For the production of fertile perithecia under laboratory conditions it is necessary to bring together cultures of the two mating types and maintain them under the appropriate environmental conditions.

The examination, by mating tests, of mass cultures of the *Fusarium* stage of this fungus that were

Geographical area	Habitat	State of fungus	Mating type
Canada			
British Columbia	potato tubers	<i>Fusarium</i>	m.t. ¹
Alberta	"	"	"
Saskatchewan	"	"	m.t. ¹ and m.t. ²
Manitoba	"	"	separately
New Brunswick	"	"	m.t. ¹
Prince Edward Island	"	"	m.t. ¹ and m.t. ²
England	<i>Polyporus rickii</i> DeVr.	<i>Gibberella</i>	separately
			m.t. ¹ and m.t. ²
New Zealand			
Scotland	wheat	<i>Fusarium</i>	m.t. ¹
Tasmania	<i>Vicia</i> sp. hops	"	m.t. ¹

isolated from decaying potato tubers in Canada as well as from additional habitats in other geographical areas has revealed that the two mating types occur separately in Nature. In no instance were the two mating types found occurring together in the same mass isolate of the *Fusarium* stage. Their occurrence together in Nature has so far been determined only from a single collection of the *Gibberella* stage. In the accompanying table is shown the geographical distribution, and habitats, of the two mating types in *G. cyanogena* so far determined by me.

The ability of the two mating types to become established separately in Nature would appear to explain why *Gibberella cyanogena* has so far not been encountered in Canada, where *Fusarium sambucinum* f. 6 is widely distributed.

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Nov. 19.

¹ Gordon, W. L., *Can. J. Bot.*, **30**, 206 (1952).

Microflora of Crêpe Rubber

COMPARATIVELY little is known about the micro-fungi normally present on the surface of native crêpe rubber. Brown¹ isolated two chromogenic penicillia and a *Fusarium* from discoloured areas of spotted crêpe. Fullerton² attributed the spotting of smoked sheet and crêpe to species of *Aspergillus*, *Penicillium*, *Fusarium* and unidentified bacteria. Schade³ obtained *Monascus ruber* and *M. purpureus* from smoked sheet. More recently, Shaposhnikov *et al.*⁴ isolated four species of *Aspergillus* and three species of *Penicillium* from smoked sheet, and obtained vigorous growth from inoculations with other common surface moulds.

As a part of a programme of research on the application of bactericides and fungicides to raw and vulcanized rubbers, initiated by the Rubber Service Laboratories of I.C.I., Ltd., in collaboration with ourselves, samples of discoloured crêpe, obtained from Ceylon⁵, were incubated in moist chambers at 25° C., and the resulting colonies of fungi were subcultured on 2 per cent malt agar until pure cultures of each infecting species were obtained. The pure cultures were grown on 2 per cent malt and Czapek-Dox agars and on pieces of crêpe rubber sterilized by steam or methyl alcohol vapour. The species isolated and their behaviour on subculture are listed in the accompanying table.

FUNGI ISOLATED FROM CRÊPE RUBBER

Original discolouration	Micro-organisms isolated from discoloured area	Colour on malt agar	Discolouration of inoculated crêpe
Black	<i>Cladoglyphus herbarum</i> (Pencoon) Link	black	black
Blue-black	<i>Helminthosporium</i> sp. <i>Syncephalastrum</i> sp. <i>Penicillium italicum</i> Sopp Black pycnidia (unident.)	black grey red black	black grey brown —
Brown	<i>Penicillium chrysogenum</i> Bourge	red	brown
Yellow-brown	<i>Margarinomyces halophilus</i> van Beyma	black	black
Orange	<i>Beauveria subtilis</i> Cohn <i>Penicillium citrinum</i> Thom <i>Penicillium variable</i> Sopp <i>Penicillium purpurogenum</i> Stoll	— yellow orange red	— yellow brown-pink red
Violet	—	—	—
Green	—	—	—

Repeated culture of the green- and violet-stained rubbers produced no fungal growth; unidentified bacteria were isolated from the violet-stained rubber. The commonest infection was from *Penicillia*, particularly the species *variable*, *chrysogenum* and *citrinum*. Several strains of *P. citrinum* were isolated of varying chromogenic power. Red stains apparently due to *P. purpurogenum* occurred with some frequency; *P. italicum* was found on a single culture only.

The species of *Penicillium* present on the rubbers are recorded as common in tropical and subtropical areas, and have been isolated in these areas from deteriorating military equipment.

The wide variety of infecting organisms confirms the views of Shaposhnikov *et al.* that unvulcanized rubbers can support the growth of most common microfungi and that infection is airborne during the drying of the crêpe sheet.

Thanks are due to the Rubber Research Institute of Ceylon, which provided the samples of discoloured crêpe for examination.

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Dec. 2.

¹ Brown, W., *Bull. Rubb. Growers' Assoc.*, **6**, 682 (1924).

² Fullerton, R. G., *Quart. J. Rubb. Res. Inst. Malays.*, **1**, 66 (1929).

³ Schade, A. L., *Mycologia*, **29**, 295 (1937).

⁴ Shaposhnikov, V. N., Babotnova, I. L., Yarmola, G. A., and Kusmetsova, V. M., *Mikrobiologiya*, **31**, 280 (1952).

⁵ Rep. Rubb. Res. Bd., 1952 (1953).

Poetry and Science

IF the report in *Nature* of January 16 of the discussion at the Penn Club on "Poetry and Science" is accurate, some interesting confusions seem to have arisen. We are told that poets and scientists were antagonistic in the past, because they were under the mistaken impression that there was a real external world—so Prof. H. Dingle. Stephen Spender demanded the right to a subjective knowledge of truth—as if 'knowing' could ever be wholly objective. G. S. Fraser insisted that poetry has its own criteria of exactness—which no scientist could possibly dispute. Mr. N. W. Pirie is reported to have said that scientists discard statements they dislike—surely with some indication of the criteria which, if not satisfied, arouse his dislike.

It must be obvious that both poet and scientist have their own disciplines for exploring human reactions to the world they live in, that these disciplines can be studied, and a methodology of science and of poetry worked out and compared, and seen in their complementary aspects. One gained the impression, from the report, of a confused battle between the Subjectives and the Objectives with Prof. Dingle above the storm, content to know that the battle was taking place in a non-existent universe. That unreality is, at any rate, some consolation to those of us who try to live rationally in this world.

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FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, March 15

SOCIETY OF CHEMICAL INDUSTRY, CROP PROTECTION PANEL of the AGRICULTURE GROUP (in the Rooms of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. R. L. Wain: "Some Recent Developments in the Field of Plant Growth Substances".

UNIVERSITY OF LONDON (in the Chemistry Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. M. Bijvoet (Utrecht): "The Structure of Optically Active Compounds in the Solid State: and some other Problems". (Further Lectures on March 17 and 19.)*

INSTITUTE OF METAL FINISHING (in Room 153, Connaught Building, Northampton Polytechnic, St. John Street, London, E.C.1), at 6 p.m.—Mr. P. Spuro: "Recent Developments Concerning Electroforming of Moulds".

BRITISH SOCIOLOGICAL ASSOCIATION (at the Royal Society of Arts, 6 John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Mr. Tom Harrison: "Bolton and Borneo—15 Years of 'Overheads'".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Lieut-Colonel Sir Rupert Hay: "The Persian Gulf States and Their Boundary Problems".

Tuesday, March 16

UNIVERSITY OF LONDON (in the Anatomy Theatre, Communication Research Centre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. D. B. Fry: "The Experimental Study of Speech".*

BRITISH ORNITHOLOGISTS' UNION (in the Meeting Room of the Office of the Zoological Society of London, Regent's Park, London, N.W.1), at 6 p.m.—Annual General Meeting.

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. F. H. Carey: "The Development of the Spill Flow Burner and its Control System for Gas Turbine Engines".

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the REFRACTORIES ASSOCIATION OF GREAT BRITAIN and the INSTITUTE OF CLAY TECHNOLOGY, at the Grand Hotel, Sheffield), at 7.30 p.m.—Dr. A. T. Green: "Dr. Mellor—His Life and Work".

Wednesday, March 17

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. E. D. Adrian, O.M., F.R.S.: "Recent Developments in the Study of the Sense Organs" (Trueman Wood Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. A. Kingsley Wells and Mr. A. Olive Bishop: "An Appinito Fades Associated with Certain Granites in Jersey, Channel Islands"; Dr. J. D. Lawson: "The Geology of the May Hill Inlier".

ROYAL METEOROLOGICAL SOCIETY (at 40 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.*

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, SOCIAL PHILOSOPHY SECTION (in the Portico Library, 57 Mosley Street, Manchester 2), at 5.30 p.m.—Discussion on "Social Problems of the Welfare State".

PHYSICAL SOCIETY, LOW TEMPERATURE GROUP (at the Science Museum, South Kensington, London, S.W.7), at 5.30 p.m.—Symposium on "Hydrogen Liquefaction".

Thursday, March 18

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Prof. L. S. Hearnshaw: "Attitudes to Work" (Chairman's Address).

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 2.30 p.m.—Annual General Meeting. Mr. W. N. Sproson: "A New Photo-electrical Optical Test Bench"; Mr. L. C. Jesty: "Recent Developments in Colour Television".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at the Chemical Research Laboratory, Colindale Avenue, Hendon, Middlesex), at 2.30 p.m.—Scientific Papers.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Meeting for Election of Fellows. 4.30 p.m.—Mr. E. F. Bowden, F.R.S., and Mr. P. H. Thomas: "The Surface Temperature of Shifting Solids"; Mr. R. F. King and Mr. D. Tabor: "The Strength Properties and Frictional Behaviour of Brittle Solids".

INSTITUTE OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. G. Chad Norris: "Some Grinding Tests with Spheres and Other Shapes"; Mr. G. Lowe Fain: "A Method of Predicting the Performance of Commercial Mills in the Fine Grinding of Brittle Materials".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. G. Hawkes: "Taxonomic Studies on the Tuber-bearing Solanum".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. F. E. Bomall: "Endomorphisms of Partially Ordered Vector Spaces".

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDINGS MATERIALS GROUP (in the Lecture Hall, Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Mr. O. van der Poel (Amsterdam): "A General System Describing the Visco-elastic Properties of Bitumens and their Relation to Routine Test Data".

INSTITUTE OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.30 p.m.—Sir Christopher Hinton: "Atomic Energy Made Easy".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at the Royal Army Medical College, Millbank, London, S.W.1), at 7.30 p.m.—Laboratory Meeting. Chairman: Dr. F. Norman White.

Thursday, March 18—Friday, March 19

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING AND FOOD GROUPS (at the Wellesome Research Institution, 183 Euston Road, London, N.W.1), at 10 a.m. daily.—Conference on "Chemical Engineering in the Food Industry".

Friday, March 19

SOCIETY FOR WATER TREATMENT AND EXAMINATION (in the Library of the Water Examination Department, Metropolitan Water Board, Rosebery Avenue, London, E.C.1), at 9.30 a.m.—Annual General Meeting, followed by Scientific Papers.

INSTITUTE OF PETROLEUM (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2), at 2.15 p.m.—Symposium on "Metal-Working Oils".*

INSTITUTE OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Annual General Meeting.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. N. Pevsner: "Sir Christopher Wren".

Saturday, March 20

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, SCIENTIFIC AND TECHNICAL GROUP (in the Clarendon Laboratories, Oxford).—Whole Day Conference on "Photochemistry and Photography".

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, University College, Gower Street, London, W.C.1), at 10.45 a.m.—Annual General Meeting, followed by the reading of Scientific Papers.

BRITISH PSYCHOLOGICAL SOCIETY (in the Psychology Department, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. W. Mays: "Piaget's Genetic Theory of Concept Formation".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PHYSICIAN and ENGINEER, Scientific Officer, Experimental Officer, or Assistant Experimental grades, at the Ministry of Supply Experimental Establishment, near Salisbury, Wilt.—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.45/344 (March 20).

LECTURER IN PHYSICS—The Secretary, Birbeck College, Malet Street, London, W.C.1 (March 23).

SCIENTIFIC OFFICER, Grade 8 (with a degree in mechanical or aeronautical engineering, or equivalent qualifications, together with experience in the conduct of aerodynamic investigations, preferably of supersonic flight), at the Long Range Weapons Establishment, Salisbury, South Australia, to undertake investigations of an aerodynamic nature concerning supersonic guided missiles—The Senior Representative (A.P.F.), Department of Supply, Australia House, Strand, London, W.C.2 (March 23).

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree or equivalent qualification in physics, chemistry or metallurgy) for development work on carbon for nuclear reactors, involving structural studies of porous solids—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berkshire (March 23).

ASSISTANT LECTURERS IN BOTANY (preferably with special qualifications in microbiology), ORGANIC CHEMISTRY, PURE MATHEMATICS, PHYSIOLOGY and ZOOLOGY—The Secretary, Birbeck College, Malet Street, London, W.C.1 (March 26).

LECTURER (with special qualifications and experience in the field of vocational selection, guidance and training) in the DEPARTMENT of PSYCHOLOGY, to be responsible for vocational courses leading to a newly established postgraduate Diploma in Applied Psychology—The Registrar, The University, Liverpool (March 26).

ASSISTANT OFFICIAL ANALYSE (with at least an honours degree in chemistry, or the A.B.L.C. Diploma, and preferably with a knowledge of French)—The Greffier of the States, States Greffe, Jersey, Channel Islands (March 31).

LECTURER IN AGRICULTURAL BOTANY—The Secretary of University Court, The University, Glasgow (March 31).

LECTURER (with an honours degree in petroleum production engineering, chemical engineering, mechanical engineering, or geology, with postgraduate or industrial experience in engineering) in PETROLEUM PRODUCTION ENGINEERING, in the Chemical Engineering Department—The Registrar, The University, Edgbaston, Birmingham (March 31).

SCIENTIST (with first- or good second-class honours degree or equivalent in physics, engineering, mathematics or statistics, and several years industrial or laboratory research experience) in the FIELD INVESTIGATION GROUP, Scientific Department, to lead a team carrying out field work at collieries—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/750 (April 8).

SENIOR LECTURER IN AGRICULTURAL BOTANY at the University College of the Gold Coast—The Secretary, Inter-University Council, 1 Gordon Square, London, W.C.1 (April 8).

SENIOR LECTURER in the TEACHING OF PHYSICAL SCIENCE—The Secretary, University of London Institute of Education, Malet Street, London, W.C.1 (April 10).

CHAIR OF THEORETICAL PHYSICS, tenable at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 18).

RESEARCHER IN PHYSICS and PHYSICIST at Ministry of Supply Experimental Establishments, at Farnborough, Havant, Malvern, Stevenage, and elsewhere, mainly in southern England, for research, development or design of telecommunications and radar equipment, guidance and control systems, instrumentation for variety of research problems—The Ministry of Labour and National Service, Scientific and Technical Register (K), 26 King Street, London, S.W.1, quoting D.490/58A (April 13).

LECTURER IN THE SHERLOCKHOLME SCHOOL OF PHYSIOLOGY—The Dean of the Medical School, St. Thomas's Hospital, London, S.E.1 (April 14).

LECTURER/SENIOR LECTURER IN MATHEMATICS (Pure Mathematics) at the University of Sydney, Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, April 17).

UNIVERSITY LECTURERS, and UNIVERSITY ASSISTANT LECTURERS IN THE FACULTY OF MATHEMATICS—The Secretary, Faculty of Mathematics, University of Cambridge, The Arts School, Bennet Street, Cambridge (April 30).

TURNER AND NEWALL RESEARCH FELLOW IN ENGINEERING, INORGANIC CHEMISTRY or PHYSICS, or other allied science—The Registrar, The University, Leeds 2 (April 21).

CHAIR OF GEOGRAPHY—The Secretary, The University, Edinburgh (April 30).

RESEARCH FELLOW IN PURE SCIENCE at the University of Durham—The Secretary, 38 North Bailey, Durham (April 30).

LEVERHULME STUDENTSHIPS and SMITH STUDENTSHIPS IN CHEMICAL ENGINEERING—The Registrar, University College London, Gower Street, London, W.C.1 (May 15).

BROUGHTON (with at least a good second-class honours degree with appropriate postgraduate experience) at the West African Fisheries Research Institute, Sierra Leone—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODH197/194/01.

DEMONSTRATOR IN ORGANIC CHEMISTRY and DEMONSTRATORS IN INORGANIC CHEMISTRY—The Registrar, The University, Nottingham MASTER TO TEACH PHYSICS up to University Scholarship standard—The Headmaster, 84 Bees School, Cumberland.

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REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Air Ministry: Meteorological Office. Averages of Temperature for Great Britain and Northern Ireland 1931-50. Pp. ii+86 (London: H.M. Stationery Office, 1953.) 2s. net. [121]

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines, under the Coal Mines Act, 1911, for the year 1952. Scottish Division. By H. R. Houston. Pp. ii+22. (London: H.M. Stationery Office, 1953.) 1s. 3d. net. [121]

Organismic Functionalism. Vol. 1, No. 1 (January, 1954). Pp. 46. (Nottingham: The Ritter Press, Alston, Alexandra Park, 1954.) 2s. 6d. [121]

Eighty Annual Report and Accounts for the year ended 30th September, 1953. Pp. 12. (London: Negretti and Zambra, Ltd., 1954.) [121]

Department of Scientific and Industrial Research. Summary of Progress of the Geological Survey of Great Britain and the Museum of Practical Geology for the year 1952. With Report of the Geological Survey Board and Report of the Director. Pp. iv+72. (London: H.M. Stationery Office, 1953.) 2s. 6d. net. [121]

Aero Research Technical Notes. Bulletin No. 132: "Araldite" Miscellany Pp. 8. (Dunford: Aero Research, Ltd., 1953.) [121]

Communications of the Dublin Institute for Advanced Studies. Series A, No. 10: Papers read at Cosmo Ray Colloquium, September, 1951. Pp. 196 (19 plates). (Dublin: Dublin Institute for Advanced Studies, 1952.) [121]

Philosophical Transactions of the Royal Society of London. Series A, Mathematical and Physical Sciences. No. 914, Vol. 245 (12 January 1954): Spectral Theory for the Differential Equations of Simple Birth and Death Processes. By W. Ledermann and G. R. H. Reuter. Pp. 321-366. 11s. No. 915, Vol. 246 (12 January 1954): The North Sea Storm Surge of 31 January and 1 February 1953. By J. R. Rostetter. Pp. 371-400. 7s. (London: Cambridge University Press, 1954.) [121]

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines, under the Coal Mines Act, 1911, for the year 1952. North Eastern Division. By C. W. Scott. Pp. ii+30. (London: H.M. Stationery Office, 1953.) 1s. 6d. net. [121]

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London School of Hygiene and Tropical Medicine. (University of London.) Incorporating the Ross Institute. Report on the work of the School for the year 1953-1953. Pp. 126. (London: London School of Hygiene and Tropical Medicine, 1954.) [121]

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Nigeria: Agricultural Department. Special Bulletin No. 5: Notes on the Main Types of Nigerian Soils. By Dr. H. Vine. Pp. 6+1 map. (Lagos: Government Printer, 1953.) 2s. 6d. [61]

Durban Museum and Art Gallery. Annual Report for the Municipal Year 1952-53. Pp. 12. (Durban: Durban Museum and Art Gallery, 1953.) [61]

Report of Her Majesty's Astronomer at the Cape of Good Hope to the Secretary of the Admiralty for the year 1952. Pp. 16. (Observatory, C. P.: Royal Observatory, 1953.) [61]

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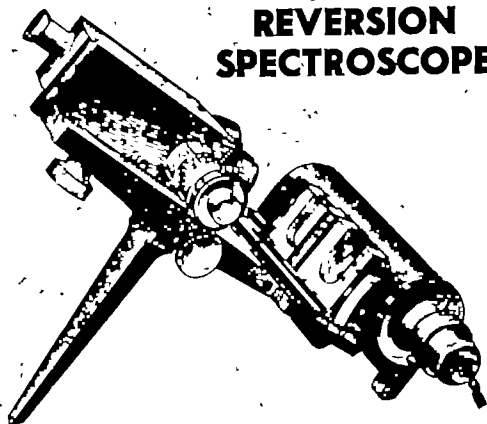
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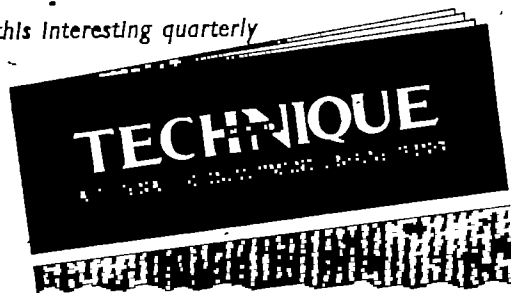
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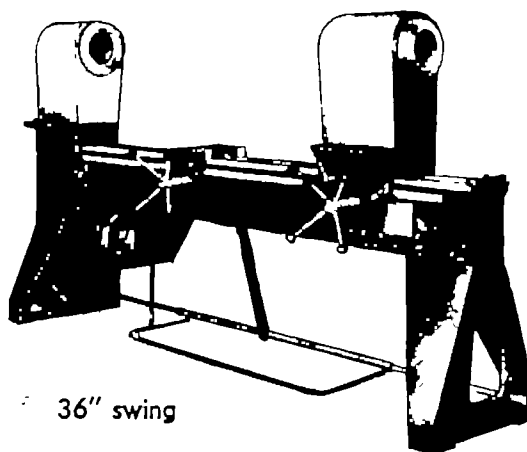
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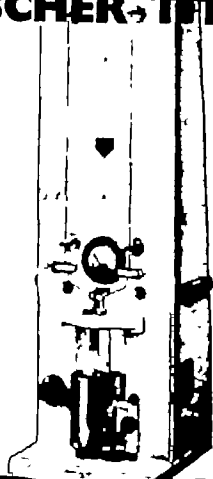
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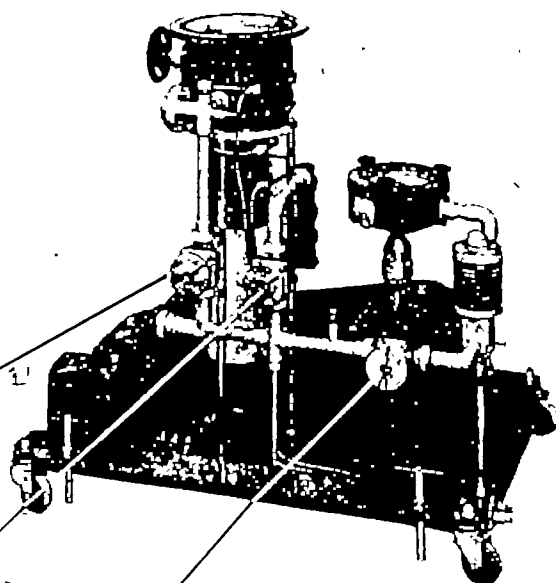
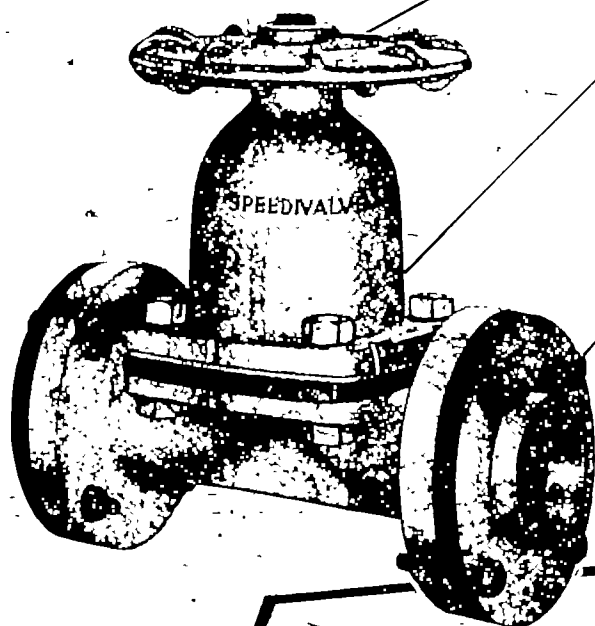
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BROADCASTING AND TELEVISION: MONOPOLY OR COMPETITION?

THE stimulating address on some problems of communication which Barbara Wootton delivered to the Aslib Conference at Nottingham last autumn was essentially a plea for the use of the right tool for the right purpose. Its analysis of the way in which channels of communication may be blocked, and particularly of the difficulty in the way of communicating exact or quantitative knowledge, has a profound bearing on the current discussion of the future of television and even of broadcasting itself. Prof. Wootton could point to some striking illustrations of the inefficiency of broadcast talks, and even of the limitations of written communication where mathematical precision or quantitative expression is demanded; she thinks it is doubtful whether the average citizen understands more than about a quarter of such a broadcast talk as those given in the series "Topic for To-night", and that quarter may well be a random collection of the ideas presented to him, in which subsidiary points may figure unduly.

The limitations are set, not so much by the imperfections in the technique of the broadcaster, as by the intelligence of the listener, and, as Prof. Wootton well indicates, this position plays into the hand of the emotional broadcaster, even where precision is essential in order to afford a sound judgment. Nor will the difficulty be resolved merely by drawing a sharper line between objectively established fact and subjective speculation, important as is that distinction. Seen from the point of view of adult education, the imaginative art must be enlisted to secure from the listener or reader or viewer the educational effort and the mental co-operation which are indispensable to a clearer understanding of questions of fact whether in social science, in public affairs or in any other field of human knowledge and endeavour.

In this position lies the real danger which may arise when broadcasting and television are regarded on any other level than that of a public service. Because neither broadcasting nor television in itself demands more active co-operation from listener or viewer than the turning of a knob, they can all too easily encourage the passive receptivity that offers the great danger to standards of public taste. Now that the Television Bill has been published, it is important to consider carefully the issues that are raised.

"Television", as the Government's White Paper, quoting from the report of the Beveridge Committee, admits, "has great and increasing power in influencing men's minds"; but that power, unless exercised responsibly and imaginatively, confirms men in their passivity and prejudices rather than uplifts and enlightens them. Evidence enough of this tendency was quoted in the parliamentary debates nearly four months ago on the Government's proposals and in Lord Simon's recent book "The B.B.C. from Within"*, and the educational aspect of these two media of

* The B.B.C. from Within. By Lord Simon. Pp. 300. (London: Victor Gollancz, 1953.) 10s. net.

communication is of such vital importance that it overshadows completely the question of monopoly.

On this point there are two passages in Lord Simon's book which should be noted. In cultural matters, he points out, the B.B.C. has great influence; it does consciously seek—and often with outstanding success—to raise standards and to create new tastes. In politics and in religion, however, it is entirely neutral; its broadcasts are proportional to the demands of organized public opinion and it has no power and shows no initiative, except in freely encouraging to the very best of its ability the broadcasting of information, opinion and discussion by leaders of thought in all religious and political fields. Lord Simon dismisses as unfounded the idea that the B.B.C. is dangerously powerful. Its influence is great and its practice and policy sufficiently diversified to secure reasonable freedom on the air, if not sufficiently so to satisfy all minorities. He regards its influence on the whole as promoting, through its news, talks, discussions and features, an informed and responsible British democracy, more tolerant and wiser than many others.

That much lies to the credit of the public service ideal, though even here the danger is not excluded that broadcasting as well as television, if too much time is given to it, may prove inimical to the formation of independent-thinking citizens of democracy. That danger is bound to be greater if either passes under the influence or control of commercial interests, whose concern with public service is a secondary matter, and whose dependence upon advertising for revenue renders sales promotion a dominant motive. Such a self-denying ordinance as the exclusion of sensational television between the hours of six and eight in the evening is too much to expect in these conditions. Commercial television or broadcasting might conceivably assist the introduction of a higher standard of political commentator. The failure of the B.B.C. to use regular political commentators and so to build up their influence is cited by Lord Simon as evidence of the B.B.C.'s impotence to influence opinion in public affairs in any given direction. Commercial television or broadcasting might remedy this defect of monopoly and facilitate the introduction of commentators of the standard of the best of American commentators. It could equally open the door to the more sensational and irresponsible, and this disadvantage of monopoly may well be corrected more widely by some other means such as the alternative public service concerns, towards which Lord Simon himself leans.

Hitherto, in Great Britain, the existence of monopoly has been consistent with the responsible exercise of influence rather than power in broadcasting. The British Broadcasting Corporation has discharged its trust in a way which has won almost universal tribute. Nevertheless, the debate on monopoly was opened rather than closed by the report of the Beveridge Committee, and the alternatives to the present system are the subject of objective, as well as subjective, inquiry and discussion. Concern, moreover, at the effects of broadcasting and

television on society has sharpened anxiety about the possible consequences of their influence being exerted by any bodies other than those whose first responsibility is to provide a public service. In television and in broadcasting we have techniques which, wisely used, could, as Lord Simon's book indicates, be educational instruments of untold benefit to mankind. To them indeed apply the words with which H. A. L. Fisher, in 1935, closed the third volume of his "A History of Europe": "The developing miracle of science is at our disposal to use or abuse, to make or to mar. With science we may lay civilization in ruins or enter into a period of plenty and well-being the like of which has never been experienced by mankind". When Fisher wrote that, an insane racialism threatened, as he put it, to rupture the seamless garment of civilization. The rents have not yet been closed nor the wounds healed, and this question of television and broadcasting underlines his plea that we should replace our squandered treasures of humanity, toleration and good sense.

It is therefore not surprising that the vice-chancellors of thirteen universities of Britain should have recorded their conviction in a letter to *The Times* that to place television on a commercial basis, which must mean that the programme is determined by the criterion not of merit but of popularity, would be to throw away an instrument with very great possibilities for good. Informed opinions differ as to how much positive harm is done to the young by commercial television in other countries; but, as the vice-chancellors rightly point out, we have recently recognized in the television of the Queen's coronation the power of television for good, and if we deliberately discard that power we can never hope to recover it, and in this view the vice-chancellors have received strong support from other educational associations. The National Union of Teachers, the Workers' Educational Association and the Association of Education Committees, for example, have all made written representations on commercial television to the Minister of Education.

The debate which took place in the House of Lords on November 25 and 26 gave further indication that many thoughtful people are unalterably of the opinion that to commercialize television would mean both a danger, especially to the young, and a loss of great opportunities for good. That expression of opinion was virtually ignored by Government spokesmen in the Parliamentary debates, and on December 14, in a further letter to *The Times*, the vice-chancellors, while welcoming the Government's pledge against direct sponsoring, urged that the power of television was enormous and that any system which would permit commercial considerations to exercise a determining influence on programmes was most unwise. It would, in fact, have been a dereliction of duty if, as responsible leaders in education, they had not reaffirmed their strong and continuing belief that such a risk should be avoided.

An impressive feature of the report of the Beveridge Committee was that, in spite of an unconcealed distrust of monopoly, the Committee, with one dissentient,

recommended the continuance of the monopoly of the British Broadcasting Corporation as the lesser of two evils. It is now clearer than two years ago that the debate on monopoly has only begun: it is equally clear that, among those who are most alive to all that is involved, there is as yet no general agreement as to the wisest alternative to monopoly—in broadcasting or in television. For this reason the Archbishop of Canterbury's appeal to the Government that it should recognize that its proposals are by no means the only ones, that there may be better alternatives, that the real object should be an agreed solution which will satisfy the great majority of the nation, and that until that search has been made and failed the party machine should not be invoked, found strong support not only in the debate from Lord Beveridge himself, Lord Layton, Lord Waverley and others, but also outside the House. Thus the statement by the Assistant Postmaster-General, Mr. L. D. Gamman, that in preparing legislation the Government would consider carefully and sympathetically any alternative practicable proposals for terminating the B.B.C. monopoly, and the declared objective of the policy indicated in the White Paper on Television Policy "to proceed with caution into this field and to safeguard this medium of information and entertainment from the risk of abuse or lowering of standards", were welcomed.

Nevertheless, there is justification for the belief that the Government has given way to commercial interests and jeopardized the whole future of broadcasting and television in Great Britain. Nothing that was said in the Parliamentary debates by Government spokesmen touched this issue: the argument was never met. Moreover, doubts as to Government intentions and good faith were fanned by another omission. The second objective of television policy was defined in the White Paper as "to reduce to a minimum the financial commitments of the State". The previous White Paper on Broadcasting stated that "in the expanding field of television provision should be made to permit some element of competition when the calls on capital resources at present needed for purposes of greater national importance should make this feasible". On the question as to how far the diversion of resources to the expansion of television is at present justified, the White Paper on Television Policy and Government spokesmen in Parliament were silent. Taken with the Government's implied intention to continue to deduct part of the British Broadcasting Corporation's licence income, the Government's attitude on the financial and materials aspect of television is thoroughly unrealistic. The grave doubts and reservations on these points expressed by the Archbishop of Canterbury and Lord Waverley were completely ignored.

The Archbishop of Canterbury, referring to these passages in the two White Papers, asked how far it is wise at this time to put much more of our national financial and other resources into intensifying the output and accelerating the development of television. It seemed to be taken for granted by Government spokesmen, as well as by others, that the purposes of greater national importance are so well supplied

with capital resources that those resources can now be diverted to the lesser purpose of competitive television. That is not a view which is likely to be shared by those who are concerned with the country's effort in scientific and technical research, and the calls which the development of atomic energy is already making on resources. In materials, as well as in trained man-power, the expansion of television is likely to compete for resources which are already failing to meet the full requirements of the Department of Scientific and Industrial Research, the universities, and industry. So far as buildings and equipment are concerned, the condemnation of the policy of both political parties in regard to schools and technical education contained in two recent reports from the Select Committee on Estimates makes nonsense of any proposals for the expansion of television until the glaring defects revealed in these two reports are in the way of being removed by appropriate allotment of the necessary resources of capital and materials, while road development might also reasonably be expected to have a prior claim.

Lord Waverley said little on this particular point; but his comment that there is at least a danger that more and more entertainment in the present circumstances may mean less and less effort left no doubt as to his misgivings. Certainly neither the Chancellor of the Exchequer nor his predecessor in that office, Mr. Hugh Gaitskell, had encouraged the belief that we can yet afford to divert national resources into the production or development of luxuries, such as is television on any serious and responsible view. Prudent consideration of available resources suggests the impartial exploration on non-party lines of the possibilities of terminating monopoly and securing the real advantages of competitive television without the dangers that dependence on revenue from advertising appears to involve.

This position gives further force to some comments of the Archbishop of Canterbury and others on the question of the licence fee for television. The Archbishop's suggestion that the licence fee should be raised as necessary to enable the B.B.C. alone to do its job well or to permit an element of competitive programmes, found support from all sides, even from those who are also prepared to experiment with advertising; and Lord Salisbury's rejection of such a suggestion ignored the Archbishop's sound comment that the licence fee should be such that people paid for what they got and did without amenities for which they could not pay. Nor did Lord Salisbury meet the point that if advertisements were introduced the revenue obtained from them should be used for subsidizing the whole service and thus avoid prejudicing hopelessly the position of the B.B.C., or the argument advanced by Lord Merthyr, Lord Moyns and others that the Government should drop its present practice of taking 15 per cent of the B.B.C.'s licence revenue. It is undoubtedly sound that, as Lord Beveridge remarked in supporting the Archbishop of Canterbury, people should pay directly rather than indirectly for their broadcasting or television.

In the early stages of the discussion, Mr. Selwyn Lloyd rejected any compromise except on the condition that an alternative system should draw some revenue from advertisements, but other spokesmen for the Government were not so unreasonable. Early in the House of Lords debate, the Postmaster-General, Earl de la Warr, had indicated the Government's readiness to consider Parliament's views before definite and detailed legislation was prepared, and even in Lord Salisbury's rather hard speech, he said that, within the broad basic principles of the Government's scheme, the Government was prepared to consider any suggestions that might be made. Lord Salisbury referred particularly to the ideas put forward by the Archbishop of Canterbury and by Lord Waverley as worthy of further study, which notably went far outside the conditions afterwards laid down by Mr. Selwyn Lloyd in the House of Commons debate.

Lord Waverley's remarks in particular deserve to be noted. He believes that no one can at present form a true estimate of the ultimate impact of television upon our economic, social and cultural life. In urging that we should wait before making the surrender involved in the Government's plan—a surrender which he is convinced would lead to a lowering of standards—he asked the Government, while accepting the principle of competition and agreeing reluctantly to the establishment of another public corporation, to look again at the finance and other features of its scheme with the view of eliminating dependence upon advertisements. Sir David Maxwell Fyfe's speech in concluding the debate in the House of Commons on December 15 was pre-eminently reasonable, and seems to hold open again the door which Mr. Lloyd had slammed. Sir David's remark, in connexion with monopoly, that the ultimate safeguard of liberty lies in diversity has implications which augur better for second thoughts by the Government on matters on which the spokesmen in Parliament were silent than might be judged from the general trend of the debates.

How important television is likely to become in moulding the civilization of the future cannot yet be judged, nor is a sound judgment likely to be formed in an atmosphere inflamed by party politics or heated argument over monopoly. There is need for much clearer thinking about the responsible exercise of power in a field relatively new and almost uncharted. Even the specific applications of television in education and the techniques demanded are still a matter for experiment, and there is indeed need that, as Lord Layton urged, as far as possible, our ventures into this new field should be made by common consent.

In the Television Bill which has now been laid before the House of Commons an attempt has been made to reach a compromise between the original proposals put forward in the White Paper and the views expressed, particularly in the House of Lords. Thus there are elaborate safeguards against the influence of advertising, and a grant-in-aid of £750,000, to be voted annually by Parliament, is proposed. In any event, it is to be hoped that when the Bill is debated in Parliament there will be

less disposition to challenge the sincerity of those who promote or oppose. The analogies drawn between broadcasting and the Press have shown some confusion of thought, but may nevertheless have been inspired by a sincere concern to secure freedom of thought and expression. So too, on the other side, legitimate concern lest commercial interests would be allowed to control the content and context of broadcasting or television may have been expressed in such a way as to impute motives or conduct to advertisers and business men from which Lord Beveridge explicitly dissociated his Committee. None the less, the danger exists, and in fact has been admitted by the Government, the proposals of which are criticised because they are regarded as providing inadequate safeguards here in a matter in which the public interest must be supreme. An agreed solution should be possible, based on hard constructive thinking and a clear appraisal alike of competing claims on national resources, and of the several alternatives to monopoly in broadcasting and television, which are open to us; among the matters which should be considered are the possibilities of regional stations and various technical advances which are in process of development.

THE PLACE OF RELIGION IN THE SCIENTIFIC WORLD

Religion and the Modern Mind

By Prof. W. T. Stace. Pp. vii+301. (London: Macmillan and Co., Ltd.; New York: St. Martin's Press, Inc., 1953.) 21s. net.

PROF. W. T. STACE has recently changed his view of the nature of reality, and this book, together with his "Time and Eternity", published in 1952, gives an account of the change and, to some extent, of the reasons for it. Put in the crudest way, his intellectual conversion might be described by saying that, whereas he formerly believed in only one world, now he believes in two. But this, of course, is an unfair statement of a position which deserves the most respectful consideration. "Religion and the Modern Mind" is brilliantly written, and, though the argument is by no means simple, it can be followed easily by any educated person.

Prof. Stace is concerned with the decay of religion which, he thinks, must mean an impoverishment of human life and experience. He traces this decay to the rise of natural science and exhibits very clearly the stages in the process. He does not hold that the development of science led logically to the waning of religious beliefs, or at least of the belief in God, because no scientific discovery or theory could tend either to prove or disprove Theism; but he believes that the non-logical process of thought can be traced by which a religious view of the universe has steadily lost authority over the modern mind. The progress of the scientific interpretation of experience which has "no need for the hypothesis" of Deity has almost insensibly persuaded men that there is no need for the hypothesis for the conduct of life. The conceptions of a 'world-purpose' and of the world as a 'moral order' have faded out of the consciousness of

multitudes who would be quite unable to give reasons for rejecting them.

The remarkable feature of Prof. Stace's position is that he maintains a naturalistic and determinist position with regard to empirical knowledge. When we look at things from the point of view of science, the whole of existence, including our minds and thoughts, is a deterministic order. But this is not the only way of looking at reality. The important thing that has happened to Prof. Stace is that he has become convinced of the validity of mystical experience. His exposition leads one to suppose, in spite of his disclaimer, that he has not only been convinced but has had some personal initiation into the mystic way. However this may be, he goes to the limit with the mystics. The mystical union, for him, is the only bliss that is really worth having. The symbols and doctrines of the great religions are only shadows of the true Reality. Nothing can be said of what the mystic knows, if knowing is the right word; only that the knowing which is beyond knowledge is the highest good. Prof. Stace does not hesitate to draw the logical conclusion. There is nothing in common between the world of empirical experience and the world of mystical insight. From the point of view of science, mysticism is illusion; and from the point of view of mystical experience, the whole of temporal existence and all the events and objects which science studies are "maya"—deceptive appearance. At one point only do the two orders touch—in the soul of the mystic where the Eternal cuts across the passing and impermanent.

Clearly, this far-reaching statement of a deeply considered view would call for a long discussion. Here it is possible only to point out that mysticism may be of a 'comprehensive' type, and there have been great mystics who have found reflections of the divine Reality in Nature. It is not clear that their experience is less valid than that of the 'exclusive' mystics; and of course, as Prof. Stace is well aware, philosophical difficulties of an insuperable kind arise when we try to think out the implications of this drastic dualism of experience. When God is thought of as 'Wholly Other' we are at a loss to see how He can enter this world or our own lives. Nevertheless, this is a book which deserves to be read both for its masterly presentation of a difficult subject and for the controlled passion which gives life to every page.

W. R. MATTHEWS

CHEMISTRY OF DAIRYING

Richmond's Dairy Chemistry

Revised by Dr. J. G. Davis and F. J. Macdonald. Fifth edition, based on the previous revision by G. D. Elsdon and G. H. Walker. Pp. viii+608. (London: Charles Griffin and Co., Ltd., 1953.) 60s. net.

THIS is a very welcome revision of a book which has been a standard work of reference on dairy chemistry since 1899. The scope of the book has been somewhat widened since the last revision in 1942 by Elsdon and Walker; but the most important features of their edition have been retained. Recent research has added considerably to our knowledge of the constituents of milk, and the present authors have given a comprehensive review of this in Chapter 2. In a book of this nature it has not been possible to give more than a brief summary of

individual researches, but workers who wish to pursue the subject are provided with ample references to original papers, reviews and the titles of recent books on the subject.

A most interesting account is given on the variation in the composition of cows' milk during the past twenty years. This suggests a distinct fall in solids-not-fat, especially since 1939. Provan's figures quoted from his findings in 1949 show a fall in bulk milk from 8.9 to 8.6 per cent. The effect of breed, feeding, climate, health, age, season, etc., is discussed at length in Chapter 3. The freezing point of milk has been fully dealt with as regards its determination and the recent reports of abnormally small depressions. In two of the cases quoted, the depression of the morning milk was normal, but that of the evening milk abnormally small. This appears to have been due to the housing of the cows at night, when they were deprived of water for many hours, the water intake being copious during the daytime. In a third case the cows were kept on a starvation diet.

Useful information is given on the pH of milk and milk products, and comparisons are made between the titratable acidity of milk and the corresponding pH values. The recent work recorded on the factors affecting the keeping quality of milk powders is of considerable commercial importance and has been given due prominence. The chapters dealing with analysis have been augmented by a most useful account of the detection and determination of enzymes, which includes tests for estimating the degree of heating of milk. Other important additions are methods for the determination of metals in dairy products and statutory tests for milk.

As would be expected from authors who have devoted so many years to the subject of dairy chemistry, the present edition gives a most extensive bibliography. Upwards of twelve hundred original works are referred to and form probably the most complete bibliography on the subject yet published. The text, tables, diagrams, etc., are extremely clear, and this revised edition will be indispensable to the dairy chemist for many years.

J. KING

WESTERN SCIENCE IN RESURGENT ASIA

Men Against the Jungle

By Ritchie Calder. Pp. 232+15 plates. (London: George Allen and Unwin, Ltd., 1954.) 15s. net.

THIS book gives a graphic account of the field-work of the specialized agencies of the United Nations Organization in south-west Asia. A striking feature of the account is the speed with which modern science can be applied to the elimination of disease, hunger and illiteracy. One shot of an antibiotic can cure yaws, which in some areas affects the majority of the people. In a few months malaria, which affects practically everybody in badly infested districts, can be eliminated. Freedom from these diseases makes the people so much more vigorous and fitter to cultivate the land properly that their food production can be increased by as much as 15 per cent. Apart from major projects like the Tennessee Valley Authority to increase the area of fertile land, simple methods of improved cultivation, the use of fertilizers and selected seeds can increase the yield by 50 per cent.

The author shows that the elimination of illiteracy needs no elaborate training colleges for teachers. At primitive educational centres, natives are trained and then go back to their villages to teach old and young to read and, what is equally important, take with them an elementary knowledge of, and enthusiasm for, improved hygiene and agricultural methods which the natives can carry out themselves with their own resources.

As the author shrewdly remarks, this method of getting the natives to carry out the development themselves and by the means they understand avoids the mistake of trying to superimpose a 'pre-fabricated' Western civilization on a totally different social and economic structure. By the improvement of environmental conditions the standard of living rises, and as illiteracy disappears there will go with it the stultifying superstitions and fears of evil spirits and local gods which need to be appeased.

Scientists and politicians might well ponder over the ultimate effects of introducing Western technology to the old civilization of the East. The first result will be a fall in the death-rate and an 'explosion of population' such as occurred in England in the nineteenth century, in which case it would be doubled in fifty years. There is no reason for believing that the Asian, even the wild man of Borneo, is innately inferior, physically or mentally, to the white man. The superior technology of the West, especially in armaments, which enabled the European nations, including the offshoot North America, to get military and economic control of practically the whole world is an open book to the Asians, who now have their own universities and research organizations. All Asia may follow the example of Japan, which within forty years of adopting Western technology became a first-class world power. As the late General Smuts pointed out, the upsurge of Asia is by far the most important political event of our day. Compared with it, European problems are of minor importance.

The most important aspect of the introduction of modern technology to the East is the raising of the standard of living and increasing the physical and mental vigour of the masses which constitute more than half the population of the world, by freeing them from the debilitating effects of disease, hunger and superstition. This development, which will profoundly affect the future of human society and which receives little attention from politicians, is being promoted by the work of the specialized agencies of the United Nations Organization described in this book, which is as readable and as fascinating as a thriller. It can be commended to all those who speculate on the shape of things to come in this rapidly changing world.

BOYD ORR

DISSOCIATION ENERGIES OF DIATOMIC MOLECULES

Dissociation Energies and Spectra of Diatomic Molecules

By Dr. A. G. Gaydon. Second edition revised. Pp. xiii+262+4 plates. (London: Chapman and Hall, Ltd., 1953.) 35s. net.

THE twelfth and final chapter of this second edition of Dr. A. G. Gaydon's book is headed: "The Dissociation Energies of Diatomic Molecules; Numerical Values". An extensive compilation of

data follows, covering some 275 molecules. The merit of these tables lies not only in the values recommended, but also in the assessment of the probable error limits to be associated with each of the values given. In comparatively few molecules are the dissociation energies known precisely. Dr. Gaydon lists twenty-two molecules for which the error limits lie within ± 0.01 eV., and there are a further thirty-seven molecules for which the error limits are given as ± 0.1 eV. At the other extreme there are sixty-seven cases in which the error limits range from ± 0.5 to ± 2 eV., and thirty-nine cases where a question mark is attached to the recommended value. Of the dissociation energies given by the author in the first edition, published eight years ago, no less than one-third out of a total of two hundred and fifty are now altered to a greater or lesser extent.

The major revisions in the new edition are to the last four chapters, which have been largely re-written. In these the author deals with several diatomic molecules for which the dissociation energies remain both in doubt and subject to much controversy. These controversies rage most violently in the important cases—practical and theoretical—of the dissociation energies of N_2 and CO, and—in lesser degree—of F_2 and S_2 . Dr. Gaydon joins combat with these issues with spirit and force, and presents his conclusions most persuasively.

I am inclined to agree with Gaydon's choice of values, $D(F_2) = 1.6$ eV., and $D(S_2) = 4.4$ eV. Recent evidence by Doeschner¹ (mentioned, but not elaborated upon, in the book), by Haar and Beckett², and by Barrow³, supports the chosen fluorine value, and the work of Schon⁴ and Porter⁵ is difficult to reconcile with the alternative values (3.3 eV., 3.6 eV.) that have been proposed for $D(S_2)$. The case presented for the value $D(N_2) = 9.76$ eV. is certainly strong, and indeed might have been strengthened further by mention of the studies of Kistiakowsky⁶ on the detonation velocities in mixtures of gases containing cyanogen, oxygen and nitrogen. Nevertheless, some doubts linger, and although the author clearly wins the debate into which he enters, one feels that decisive experimental proof is not yet available.

The problem of the dissociation energy of CO is tied to that of the latent heat of sublimation of graphite, $L(O)$. Dr. Gaydon favours the value $D(CO) = 11.11$ eV., and hence the so-called 'high' value, $L(O) = 170.0$ kcal./mole, but he qualifies his choice with the warning: "it is wise not to be too dogmatic".

Attempts to measure $L(O)$ directly—and these have been several—have now occupied a period of thirty years. This long-standing problem is perhaps fairly to be described as exasperating, for despite careful and determined attacks upon it by able experimentalists, the answer cannot yet be quoted with certainty. But the challenge is being met with vigour, and one feels the problem can scarcely resist solution for much longer. Indeed, the latest studies (Ohpka and Inghram⁷, Honig⁸) would seem to expose the hub of it.

H. A. SKINNER

¹ Doeschner, *J. Chem. Phys.*, **19**, 1070 (1951).

² Haar and Beckett, *Natl. Bur. Standards Rep.*, No. 1586 (1952).

³ Barrow and Caunt, *Proc. Roy. Soc. A*, **219**, 120 (1953).

⁴ Schon, *J. Amer. Chem. Soc.*, **74**, 4732 (1952).

⁵ Porter, *Disc. Faraday Soc.*, **9**, 60 (1950).

⁶ Kistiakowsky, Knight and Malin, *J. Amer. Chem. Soc.*, **73**, 2972 (1951).

⁷ Ohpka and Inghram, *J. Chem. Phys.*, **21**, 1212 (1953).

⁸ Honig, *Phys. Rev.*, **81**, 465 (1953).

La Chimica delle Fermentazioni

Microbiologia, Enzimologia, Chimica e Tecnica delle Fermentazioni. Da Virgilio Bolcato. Seconda edizione. Pp. xxiii+665. (Bologna: Nicola Zanichelli, 1952.) 5,000 lire.

THIS book is divided into four parts: elements of general microbiology; enzymology; chemistry of fermentations; and technique of industrial fermentations. One of the virtues of the book is the excellent background and perspective to the pith of the dissertation (Part 3) provided by the other parts. In Part 3 itself, not only are modern views on the mechanisms of various fermentations presented, but also older schemes are critically discussed. A further desirable feature is the description of the methane fermentation, which is frequently neglected in text-books.

The main weakness of the book perhaps resides in undue brevity in certain sections, or in actual omissions. Thus, the reviewers feel that, in Part 1, more detailed treatment should be given to the role of micro-organisms in Nature, with particular reference to the carbon and nitrogen cycles. Again, the section on classification of micro-organisms would benefit by precise definition of the bacteria, yeasts and moulds in the organic world, and by some detail of the chief families and genera comprising the bacteria. The production of antibiotics is not treated. Reference is made to quite recent developments in enzyme chemistry, often, however, most briefly, although references are given. Indeed, there are a good, up-to-date bibliography, and subject and author indexes.

Whatever its shortcomings, the virtues of the book far outweigh them. It is unfortunate that this book does not exist in English translation, for it is admirably suitable as a text-book for students of microbiological chemistry and the associated field of plant biochemistry.

R. H. HOPKINS
C. RAINBOW

A School Course In Mechanics

By A. J. Bull. Part 2. Pp. viii+157+408. (Cambridge: At the University Press, 1953.) 15s.

THIS volume, together with its more elementary companion, Part 1, is designed to provide a continuous course reaching the standards required for the papers at Advanced and Scholarship levels for the various General Certificate of Education examinations, though the author states that students wishing to prepare for open university scholarships will need to supplement it by some other book. There is no doubt that, on the whole, the author has admirably succeeded in his aim. There is evidence of a well thought-out plan and a very satisfactory presentation which suggest that Mr. A. J. Bull has great enthusiasm both for his subject and the teaching of it.

In this volume, calculus is, quite properly, used freely, and there is a wide selection of questions, many of university standard; in addition, quite a number of typical questions are fully worked out in the text.

The need for practical work as an integral part of the course is stressed, though it must be said that the author does not approach many of the topics from the experimental aspect. This makes the book severely theoretical, and although those who are more mathematically minded will not be affected, the reviewer feels that an experimental approach to

some of the problems dealt with would be helpful to the more ordinary student. There can be little doubt, however, that in his own teaching practice, Mr. Bull does introduce practical work in support of the text-book theory, and he exhorts other teachers to do likewise.

ASTM-IP Petroleum Measurement Tables

British edition: British (Imperial) Units of Measurement. Prepared jointly by the American Society for Testing Materials and the Institute of Petroleum. Pp. xv+416. (London: Institute of Petroleum, 1952.) 50s.

ONE of the latest joint efforts of the American Society for Testing Materials and the Institute of Petroleum is the publication of "ASTM-IP Petroleum Measurement Tables" (official designations being respectively D 1250 and IP 200), based on collective work started in 1946. The magnitude of the task can be readily imagined when it is realized that this and companion volumes contain thirty-nine tables involving some six hundred thousand six-digit figures (nearly four million digits); well over a quarter of a million IBM cards, weighing more than two tons, were employed in their make-up. These tables meet a demand from the oil industry and are authoritative in a computation of British (Imperial) units of weights and measures. They form part of a trilogy, including volumes devoted to United States and metric systems. The present (British) book includes tables for specific gravity and volume reduction to 60° F., and for weights per unit volume and volumes per unit weight over the gravity range 0.500-1.000, generally at intervals of 0.001. There are twenty-three separate tables in this volume, each of which is preceded with information as to purpose of the table, and also examples of how to use the data given. The completeness and accuracy of these tables are a major credit to all concerned in their compilation and, moreover, ensure a heavy international demand for this work, not only in the petroleum industry but also in a much wider field of applied science.

H. B. MILNER

Alternating Current Wave Forms

Theory and Practice. By Philip Kemp. (Monographs on Electrical Engineering, Vol. 1.) Second edition, revised and enlarged. Pp. xi+406. (London: Chapman and Hall, Ltd., 1952.) 50s. net.

MR. PHILIP KEMP'S book dealing with alternating current wave forms is one of considerable general utility to electrical engineers. It deals with the synthesis and harmonic analysis of complex periodic waves, and with the properties of such waves in relation to electrical networks.

Only elementary mathematics is involved, and the book is very suitable for the use of undergraduate students. A good deal of attention is given to the harmonic-generating properties of circuits with iron-core reactors, and the production of harmonics by cyclic variation of resistance is also considered. Harmonics in polyphase systems and in transformers in various systems of connexion and when supplying rectifiers are treated in two chapters. Two further chapters are devoted to the study of harmonics in the flux waves in electrical machines, and to the generation of harmonic e.m.f.'s in alternating-current windings.

The book gives a good general, but necessarily not detailed, treatment of the main features of the subject, both theoretical and practical.

NATURE CONSERVATION IN BRITAIN

ALMOST exactly five years have elapsed since the Nature Conservancy was constituted by Royal Charter "to provide scientific advice on the conservation and control of the natural flora and fauna of Great Britain; to establish, maintain and manage nature reserves in Great Britain, including the maintenance of physical features of scientific interest; and to organize and develop the scientific services related thereto". It is therefore a matter of some interest that the first two reports¹, one relating to the work of the Conservancy up to September 30, 1952, the second for the year ended September 30, 1953, have recently been published. It is to be hoped that the form of the second of these reports justifies the assumption that, as laid down in Section 24 of the National Parks and Access to the Countryside Act, 1949 (12, 13 and 14 Geo. 6, Ch. 97), the Nature Conservancy will "as soon as possible after the thirtieth day of September in each year, make to the Lord President of the Council a report on the discharge by them of their functions during the period of twelve months ending with that day".

Although to some extent the way has been paved for the Nature Conservancy by the pioneer work of the Royal Society for the Protection of Birds, the National Trust, the Society for the Promotion of Nature Reserves and a few other and more local societies, nevertheless the Nature Conservancy faces a formidable task, and one which seems likely to become more and more difficult of achievement as the impacts of new claims for land, and of modern techniques of land usage, reach their maximum demands. Many of the most interesting species of plants and animals of Britain have already become restricted, as a result of agricultural development and of urbanization, to marginal lands. Now these same retreats are the objects of competition among hill graziers, foresters, new industries and the Armed Forces. Moreover, the Nature Conservancy was constituted immediately following a succession of years during which dramatic changes were imposed upon many areas under the demands of war-time economy. War agricultural committees drained and ploughed much land which had never before been cultivated, huge acreages were disciplined into landing fields, industry was dispersed widely into former rural areas, and battle-practice schools took over many square miles of land as gunnery and bombing ranges or for manoeuvres with armoured vehicles.

It is not surprising, in view of this, that, despite the preparatory work of the Nature Reserves Investigation Committee and, following that, of the Wild Life Conservation Special Committee, it has proved necessary to organize a complete survey of England and Wales in order to determine the conditions now existing, and so to provide, as it were, an up-to-date register of the status of the wild life of the country, and at the same time to determine what measures may now be necessary in order to conserve what we have left of it. It is satisfying to read that such a survey was very nearly complete by 1952, and by September 1953 more than one thousand sites had been listed in England alone as being of sufficient importance to merit notification to local planning authorities under Section 23 of the 1949 Act. The

protection granted thereby is by no means complete, but it ensures that the Conservancy will be consulted before any new development is permitted which may modify the conditions within such a listed area.

In a country so small and densely populated as Britain, the establishment of Nature reserves is not lightly to be undertaken. Land is a scarce commodity, and its use must be fairly and wisely allocated among the many claimants for it. Moreover, the proper maintenance of a reserve for scientific study demands the goodwill and understanding of the public. Some reserves have been maintained for many years, notably under the aegis of the National Trust and by such bodies as the Royal Society for the Protection of Birds, the Society for the Promotion of Nature Reserves and the Norfolk Naturalists' Trust; readers of the present reports will note with satisfaction the mutual co-operation which the Conservancy has established with these bodies. The establishment of new national reserves is proceeding commendably slowly in view of the need for very careful selection. The view expressed in the second report by the Conservancy that this rate is disappointingly slow may be discounted. Eleven sites have been declared in England and Scotland, and another twelve acquired too recently for declaration to have been completed by the end of the Conservancy's year. By far the largest are the Beinn Eighe Reserve near Loch Maree and the Moor House property in Westmorland, both of which comprise some 10,000 acres. The remainder are smaller areas, many of them reserved for their special interest, such as the famous yews of Kingley Vale, the brook conditions of Cavenham Heath, the fens, broads and sand-dunes of various Norfolk and Suffolk sites, and the remarkable broken cliff conditions of the Dowlands landslip in east Devon. Some of these have already been in the care of a national or local society, which has now transferred the trusteeship to the Conservancy; others have been leased or purchased, while yet others, including the sites of both the Piltown and the Swanscombe skulls, have been presented.

Section 21 of the 1949 Act empowers local authorities, in consultation with the Nature Conservancy, to create local Nature reserves. Little surprise will be expressed that to date very few authorities have taken such powers. One Scottish and two English county councils have, however, shown their practical interest, and it is not over-optimistic to expect that the number of such local reserves may increase steadily, if but slowly. No doubt the still existent framework of the old Nature Reserves Investigation Committee's county sub-committees can be of use here, in bringing to the attention of their local authorities habitats which require protection and for which the establishment of a local reserve may be feasible.

The wider functions of the Conservancy, namely, the provision of advice upon, and the promotion of research into, the conservation and control of natural populations, present a multitude of problems, not the least of which is our fundamental ignorance of the ecological factors which determine the status of even the commonest of our animals and plants. The science of ecology is still young, and the rate at which

its study yields comprehensive results must be slow, because of the nature of its material and of the intricacy of the complex of physical and biotic factors within which all living organisms exist. It seems, therefore, that the Nature Conservancy may for some years be at best a one-eyed adviser, except where problems relate to only the most simple factors. It is relevant to emphasize that in the case of each of the four examples quoted in the first report no adequate answer could be returned. In fact, the reply was virtually, "We do not know, but we will try to find out", and research has been initiated in an effort to discover the solution.

To biologists therefore, as indeed to all who are prepared to take an objective view of conservation, the most interesting and stimulating sections of these two reports are those announcing the establishment and organization of the Conservancy's own research stations, at Merlewood, with Moorhouse at its doorstep, at Anancum in the Beinn Eighe Reserve, and at Furzebrook in Dorset. Coupled with this must be Appendixes V, VI and VII to the second report, in which are listed the grants awarded to universities and other organizations for the development of research into specific field-problems. One of the strongest deterrents to the initiation of fundamental ecological research, particularly in relation to animal populations, has been the breadth of the task which must be faced. Even the so-called autecological study of the bionomics of a single species must involve the investigator in an infinitude of problems in which the physical factors of climate and micro-climate, geology and soil structure and physiography may be involved, while willy-nilly an extensive study of the lives and relationships of a greater or lesser number of other species must be examined in order to determine the nature of their influence upon the species in which the worker is primarily interested. He must therefore be equipped in some measure as meteorologist, pedologist, taxonomist and statistician, and in a host of other techniques. Few men and women are able to attain to this width of interests, and in practice aid is sought from other experts in the solution of the many problems which have to be examined.

Synecology—the study of whole habitats and of the total assemblages of plants and animals within them—presents a still greater complexity of pattern, and demands so high a degree of concentration, knowledge and labour that few investigations of this kind have been successfully concluded. Nevertheless, the autecology of any species cannot be elucidated without reference to the synecology of the habitat in which it lives. It follows, therefore, that the ultimate aim of ecological science must involve a detailed synecological picture of at least the major habitats of the world. Only then will it become possible to assess correctly the status of the individual species; and, from the point of view of human welfare, only then will it become possible to prophesy the consequences to be expected from any attempt to modify the status of a species, whether by encouragement, control or, in the final event, extermination.

It seems logical to expect that comprehensive ecological knowledge can only be attained through the work of teams of experts in groups of related fields; and it is therefore encouraging to observe the nucleus of one such team being created in the scientific staff of the Nature Conservancy. It is to be hoped that, once the organization has escaped its growing pains, its scientists will be freed from all

but the necessary minimum of administrative and advisory duties, in order that they may concentrate on research. Concurrently, the programme of assistance to universities and to reputable naturalist organizations is warmly welcome. There is a wealth of talent among amateur naturalists, about which they themselves are frequently unduly humble. The exact observer who is prepared to devote his leisure to the ordered study of an area, or of a group of animals or plants, can, and does, make as important contributions to biological knowledge as do many professional scientists. Indeed, the increased load of administrative and teaching duties which besets the university teacher is usually now so heavy as virtually to preclude him from spending sufficient time, at the right times, in the field. As a result, much of his ecological work must be done by proxy. It is here that the training and research grants made by the Conservancy to university departments are so important. Thus, not only is a continual stream of apprentice recruits provided, but also the experienced ecologist is enabled to stimulate and direct work for which he himself no longer has time or freedom.

In conclusion, it is relevant to refer to the 1947 report of the Wild Life Conservation Special Committee¹. This committee examined the problem which has been adumbrated in the foregoing paragraphs, and made a number of recommendations, of which the most stimulating was perhaps that mooted the idea of freedom of movement of members of staff between museums, the Nature Conservancy and university departments. The ecological worker would thereby gain a wide experience of different disciplines, techniques and methods of attack upon his problems. Such increased versatility is so patently desirable as to create the hope that the idea has not been pigeon-holed and forgotten.

L. A. HARVEY

¹ The Nature Conservancy. Reports of The Nature Conservancy for the period up to 30th September 1952. Pp. iii+52. 1s. 3d. net. Report of The Nature Conservancy for the Year ended 30th September 1953. Pp. iii+81. 1s. 3d. net. (London: H.M. Stationery Office, 1953.)

² Conservation of Nature in England and Wales. Cmd. 7122. (London, 1947.)

RECENT ADVANCES IN ANIMAL MORPHOGENESIS

THE conference sponsored by the editorial board of the *Journal of Embryology and Experimental Morphology* and held in London during January 9-12 permitted a large number of biologists to hear and discuss accounts of recent work on many major aspects of animal morphogenesis. For this opportunity they were primarily indebted to their Continental colleagues, whose participation has provided an important stimulus to British interest in this field.

That rewarding work may still be found in the exploration of the classical problems of embryology was shown by Prof. J. Pasteels (Brussels), who described the first fruits of an investigation of embryonic stages of reptiles from the Belgian Congo. He has been able to show that the migration of the primordial germ cells to the gonadal ridges by a vascular route, long known in birds and *Sphenodon*, occurs also in lacertilians. A study of body form and brain morphology in species of different habits showed that relative functional importance in the adult can be anticipated by the embryo at a remarkably early stage. The brains of embryo

chameleons (animals which in the adult rely largely upon their visual sense) and those of the embryo *Mabuia* (in the adult largely olfactory) show early differences in the size of optic and olfactory centres. Similar considerations seem to govern the form of the body generally and of the limb, both of which in adult lacertilians may show wide differences in form and function.

Although the general configuration of the embryo can show a precocious anticipation of the functional adaptations of the adult, things are not necessarily the same at the histological level. Prof. A. Stefanelli (Rome) described cells within the optic tectum of teleost fishes which are bipolar in form and possess a recurrent branch arising from the outer fibre. To see how far their differentiation was dependent upon function, studies were made of their development in oviparous fish; in viviparous fish, in which animals before and after birth were compared; and in blind cave fish compared with related forms with vision. Blind fish, in which the eyeball is normally nearly completely enclosed in a bony capsule and in which there is no functional optic nerve, may nevertheless possess some of these neurones with their major features intact. Blindness in this species seems to have led to a reduction in the number of neurones subserving vision without altering the general features of the histogenesis of those surviving.

Prof. F. E. Lehmann (Berne) has made an electron microscope study of the cytoplasmic constituents of blastomeres of known morphogenetic properties from the eggs of the oligohaste *Tubifex* and of the sea-urchin. The technical problems of preparing the material have been overcome by treatment with glycerine or sucrose, which makes the cells brittle and easy to isolate from the germ and also dehydrates them sufficiently to inhibit autolysis. Fixation by osmium tetroxide provides good preservation of mitochondria, but a more acid fixative is required for the study of microsomes. The cells studied in the *Tubifex* germ were the somatoblasts 2d and 4d, the first giving rise to ectoderm and the latter to mesoblast in normogenesis. The cytoplasm of these cells was shown to differ in the density of the population of mitochondria—4d having many more than 2d—and in the nature and numbers of smaller inclusions. The microsome populations of different cells in the sea-urchin blastula also showed characteristic differences. In the micromeres are found many small microsomes, while there is a gradient in the concentration of mitochondria from animal to vegetal pole with a maximum at the animal pole.

Prof. Chr. P. Raven (Utrecht) gave an account of the effects of lithium ions on the development of *Limnaea stagnalis*, and of some ways in which these effects could be modified. Treatment with lithium chloride may induce exogastrulation and cyclocephalic malformations—in extreme cases cyclopia itself. These two effects are, however, independent, and it is suggested that the effect of lithium is both to weaken an animal field and to disturb the vegetal pole material. There is evidence that exogastrulation and cyclopia are independent consequences of a causal chain in which the lithium has a primary effect mediating a secondary disturbance of the respiratory processes which is responsible for the observed tertiary effects. Combinations of other ions with lithium show that while potassium, if anything, increases the lithium effect, either calcium or potassium cyanide may exercise a protective function. Conditions of oxygen lack, which in themselves induce

exogastrulation, are not so effective in presence of lithium ions. Concentrated potassium cyanide and heat shocks may both imitate the lithium effect. Dilute potassium cyanide under conditions of anaerobiosis increases the effectiveness of the latter as an agent causing exogastrulation. Exogastrulation, but not cyclopia, can be produced by centrifugation.

The mammalian egg, still largely inaccessible to the surgical procedures used on lower vertebrates, is coming to assume its rightful place in contemporary embryological advance by the application to it of the methods of cytochemistry, and Prof. A. Daloq (Brussels) showed how great the recent increase in our knowledge of its biochemistry has been. Studies on mitochondria and other visible particles in the maturing oocyte during fertilization and the early stages of development have been combined with examinations of the distribution of nucleic acids, polysaccharides and alkaline phosphatase. During oogenesis the most important changes seem to concern the microsomes and larger visible granules, these being active in the synthesis of cytoplasm and metaplasmic inclusions. Nuclear extrusions are also important at this stage. Fertilization sees little change in the visible cytoplasmic particles; but nuclear activation is accompanied by a temporary reduction in the deoxyribonucleic acid of both sperm and oocyte nuclei. The deoxyribonucleic acid is, however, rapidly recovered as the pronuclei form. Early development sees the first appearance of alkaline phosphatase. Bilateral symmetry, already apparent in the distribution of cell constituents in the maturing oocyte, becomes marked in the later cleavage stages, and from this time onward differences in the cytoplasmic constitution of cells with different fates become apparent. To some extent it is already possible to explain the biochemical activity of these cells in terms of their capacity for performing certain morphogenetic functions.

Prof. S. Hörstadius (Uppsala) described a further analysis of the organization of the young sea-urchin germ. The reduction of Janus green in cells under conditions of diminishing oxygen tension can be used to distinguish between regions of the egg with high and those with low metabolic activity. In such conditions a normal egg will show reduction (that is, high metabolic activity) first at the vegetal pole, then in the apical region and last of all in the region of the ciliary band. Isolated animal and vegetal halves in these conditions display simultaneous onset of Janus green reduction, and this indicates that the vegetal region normally inhibits the apical one. Micromeres implanted into the side of the animal hemisphere induce a reduction centre there, and are also effective in distorting the gradient in mitochondrial density that runs from animal to vegetal poles. Work with anti-metabolites had revealed a rather surprising phenomenon, since while 8-chloroxanthene (blocking purine and nucleic acid metabolism) had an animalizing effect and phenyllactic acid (blocking amino-acid metabolism) had a vegetalizing effect, both gave rise to a number of peculiar radially symmetrical larvae of a kind that Gustafson had produced with detergents. Both substances were, in fact, acting in this way, though it is open to question how far this is relevant to their other morphogenetic effects.

In the classical experiments on neural induction in the urodele embryo the structures induced were either ectodermal in nature or associated with ectodermal inductions. It has now proved possible to

induce structures of wholly, or almost wholly, mesodermal nature. Prof. S. Toivonen (Helsinki) reported a study of inductions produced by alcohol-treated guinea-pig bone marrow after its implantation into the gastrula or when placed in ectodermal 'sandwich' explants. It is noteworthy that the tissues induced in such experiments are those which in normogenesis would arise from both endomesoderm and ectomesoderm. Secondary inductions sometimes, but by no means always, occur. The same inductor if further treated with hot water for a short period undergoes a remarkable change in properties. It now induces only structures arising in normogenesis from the ectoderm, for example, lenses and balancers, though rarely, if ever, neural cells. Prof. Toivonen believes that this change is not due to a transformation of the mesoderm inductor but results from its complete destruction, with the consequent unmasking of an ectodermal inductor that had previously been unable to express itself.

Prof. J. Brachet (Brussels) described a technique for the autoradiographic localization of labelled atoms developed in his laboratory by Mme. A. Fioq. It uses the thick emulsions prepared for the study of cosmic radiation. The method permits of the location of labelled atoms with a resolution of about 1 micron. Experiments on the oocytes of *Asterias* using marked glycine showed that the activity of the nucleolus was nearly a hundred times as great as that of either nuclear sap or cytoplasm after one hour's treatment. When applied to the process of embryonic induction the method revealed that when either labelled glycine or orotic acid is incorporated into an amphibian organizer that is then implanted into another gastrula, radioactivity can later be detected not only in the secondary neural tube but also, to a lesser extent, in the host's normal nervous system. The method can also be used to identify lithium if the preparations are subjected to neutron bombardment which splits the lithium atoms. It has been possible in this way to demonstrate a distinct accumulation of lithium in the dorsal half of amphibian gastrulae formed from eggs treated with 1 per cent lithium chloride.

Prof. O. H. Waddington (Edinburgh) reported the methods being developed in his laboratory using radioactive amino-acids and the stripping film method in the study of embryonic processes in amphibians and birds. Using radioactive methionine and glycine, it had proved possible to get usable concentrations in axolotl and *Xenopus* embryos, and radioactive methionine could successfully be introduced into chick embryos by injecting the albumen in the neighbourhood of the blastoderm and maintaining the egg at room temperature for 12-24 hr. Preliminary results suggested that significant differences in the subsequent radioactivity of different organ rudiments could be detected.

From Prof. Waddington's laboratory there also came a film, exhibited by Dr. D. A. Ede, of the development of *Drosophila*. A surprising amount of the morphogenetic activity from fertilization onwards can be seen by time-lapse cinematography of the whole egg, and shots of eggs doomed to early death by their genetic constitution showed that the method holds great promise for the study of abnormal development.

For workers on the Protozoa, cell division does not serve morphogenetic processes so much as itself set the scene in which morphogenetic processes must necessarily play their part. Prof. E. Fauré-Fremiet

(Paris) described some of the processes which accompany the division of the ciliate *Urocentrum turbo* into an anterior individual or proter and a posterior one or opisthe. In this species the kinetosomes of the meridional kineties are so arranged as to lie in circular transverse lines ending in an anterior belt or fascia and an equatorial singula. At the onset of division the singula widens by the multiplication of its kinetosomes. It is thus a morphogenetic zone corresponding to Oalkin's division zone. The singular kinetosomes then become distributed along the meridional somatic kineties to complete the morphogenesis of the anterior part of the opisthe and the posterior part of the proter. The oral ciliation presents an autonomous system with its own morphogenetic zone.

Prof. E. C. Wolff (Strasbourg) described the progress made in his laboratory in the attempt to replace chick embryo extract by known mixtures of amino-acids as a medium permitting the survival, differentiation and growth of rudimentary organs *in vitro*. Using the syrinxes, tibias or the gonads taken from bird embryos of 7-9 days incubation as explants, media composed of agar, glucose and saline to which amino-acids and vitamins had been added were tested for their power to sustain growth and differentiation over a seven-day culture period. Growth in the explants was judged by the presence of mitoses and more particularly by the increase in total nitrogen. Marked growth and differentiation in media containing many amino-acids had been obtained; but when an attempt was made to find the minimum requirements of amino-acids for the explants it was discovered that though growth can occur in media to which only a few had been added, the requirements of different organ-rudiments are not the same.

Mr. M. Abercrombie (London) described observations on chick heart fibroblasts in tissue culture which had suggested that 'contact inhibition' was an important factor determining the behaviour of the individual cells and some of the properties of the whole culture. By 'contact inhibition' is meant inhibition of movement, in directions normal to the plane of contact, in two contiguous cells. The evidence for the existence of this phenomenon comes mainly from the behaviour of the outgrowths from two neighbouring explants at their zone of junction in a fluid medium. The failure of the outgrowths to 'overlap' or be thrown into folds bears striking testimony to the unwillingness of their cells to climb over one another. Contact inhibition is not only consistent with well-known features of fibroblast cultures, but may actually explain many of them. Interactions between outgrowths of explants from different organs, and even from different species, go to confirm the generality of the phenomenon, while the three-dimensional outgrowths from explants in plasma clots show it in conditions more nearly comparable with the situation in which fibroblasts occur in the organism.

A number of the papers were accompanied by demonstrations of research material, and in addition such material was presented by Dr. S. M. Manton and Mr. K. T. Anderson illustrating maternal-embryonal connexions in viviparous Onychophora, by Prof. P. B. Medawar, Dr. R. E. Billingham and Mr. L. Brent to illustrate the principle of actively acquired tolerance of foreign cells in mammals and birds, and by Dr. D. R. Newth on the behaviour of lamprey neural crest cells in homoplastic and xenoplastic transplantation.

Dr. R. A. Beatty, Dr. M. Fischberg, Dr. J. Needham, Dr. Muriel Robertson, Prof. J. Z. Young and a number of others contributed to the discussions on the papers read.

A most valuable discussion on the nature of inducing stimuli, led by Prof. J. Pasteels, was also held. It showed that interest in this subject is still high, and that the seemingly formidable difficulties that blocked the search for a single chemical or physical agent of neural induction have not prevented the accumulation of ever more precise information on the biology of the process.

The conference was made possible by the generosity of the Royal Society, the Ciba Foundation, the British Council and the Wellcome Foundation.

D. R. NEWTH

METALLIC TRANSFER IN SCREWING AND ITS SIGNIFICANCE IN BONE SURGERY

By DR. F. P. BOWDEN, F.R.S., and J. B. P. WILLIAMSON

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EARLIER experiments have shown that when two metals are placed in contact, appreciable metallic transfer occurs from one surface to the other. If sliding takes place, the amount of metal transferred is increased considerably. A general account of this work has been given elsewhere¹.

In simple mechanical operations such as screwing or bolting, we may expect that some transfer will occur between the screwdriver and the screw or the spanner and the bolt. Although the transfer will be small, it may under certain conditions be important. For example, in modern surgery it is customary to use metallic plates to strengthen or to repair a fractured bone. These are screwed or bolted on to the bone and may remain permanently in position. The plates, screws and bolts are all made from a stainless steel which has a very high corrosion resistance. Intensive investigations have been undertaken in recent years to select the best steel for this purpose. It has been found that steel of the specification shown in Table 1 (a) is one of the most inert when in contact with human tissues². It was also found that if metal alloys of differing compositions are placed in contact in the human body, metal corrosion and 'electrolytic inflammation' in the tissues occur³. 'Electrolytic inflammation' consists in the inflammatory cells of the tissues becoming more numerous and an increased local vascularity of bone and soft tissue. This condition interferes with the normal healing of bone and soft tissues and may eventually produce heavy scarring. Orthopaedic surgeons therefore take great care that all plates and screws which are to be left in contact are made of the same alloy. The insertion of 'mixed metals' is always avoided. These plates and screws are electrolytically polished and are passivated in nitric acid. Nevertheless, it is found in practice that inflammation and corrosion do occasionally occur.

Table 1

(a)	(b)
Specification for screws and plates (per cent by weight)	Specification for tools (per cent by weight)
Carbon 0.07	Carbon 0.17
Silicon 0.30	Silicon 0.24
Manganese 0.5	Manganese 0.5
Chromium 18.0	Chromium 12.6
Nickel 8.0	Nickel 0.34
Iron 70.25	Iron 85.43
Molybdenum 2.75	

The screwdrivers, spanners and forceps used in this form of bone surgery are also made from stainless steel, but of a composition differing from that of the plates (see Table 1 b) and are less resistant to corrosion.

If small fragments of this different steel are welded on to the screws during the screwing operation, they may, when immersed in the body tissue, form small electrolytic couples which cause inflammation and accelerate corrosion. Experiments were therefore carried out to investigate whether metallic transfer occurred and to determine its amount and distribution. Measurements showed that the steel for the tools was appreciably softer (V.P.H. 150) than the steel for the screws and plates (V.P.H. 380).

Experimental. The experiments consisted of driving the screws with a screwdriver having a radioactive tip, and then determining the amounts of metal transferred from the driver to the screw heads by measuring their acquired radioactivities. In order that the forces involved should approximate as closely as possible to those occurring in an actual operation, the screws were driven into bone. The experiment was carried out using samples of splints and self-tapping screws manufactured for medical use, and a splint was fastened by four screws to a leg bone taken from fresh beef. The screws were started by drilling a small hole in the bone with an electric hand-drill and were then driven home and tightened with a screwdriver. This driver had a normal handle and shank, but, instead of a tip, had a small hole recessed into its end. Into this hole a slab of metal $\frac{1}{8}$ in. $\times$ $\frac{1}{4}$ in. $\times$ $\frac{1}{8}$ in. cut from the tip of an actual medical screwdriver was inserted and used as the screwdriver tip.

Before the experiment, this slab was irradiated in the neutron pile at Harwell and acquired a radioactivity of about $\frac{1}{2}$ mc. For the present purpose only the activity of the chromium in the steel was significant. This consists of K-radiation and γ -radiation of 0.323 MeV. The screws and the driver were degassed with suitable solvents and the first screw was driven home firmly but carefully, so as not to cause appreciable slip between the driver and head. The driver slipped slightly in the slot while the second screw was being driven in; and two deliberate slips were made along the slot of the third screw. The fourth screw was driven and tightened with the utmost caution, and no slip was perceptible.

A Geiger counter was used for measuring the acquired activity of each head. Only γ -rays were counted. Thus any radiation emanating from transferred metal adhering to the bottom of the slot was not shielded by the mass of the screw head, and the entire amount of adherent metal was recorded.

Results. The specific strength of the radioactive metal was measured by counting the γ -emission from the slab used as the screwdriver tip, in the same Geiger counter under the same geometrical conditions; the weight of this slab having been determined before irradiation. In this way the mass of metal trans-

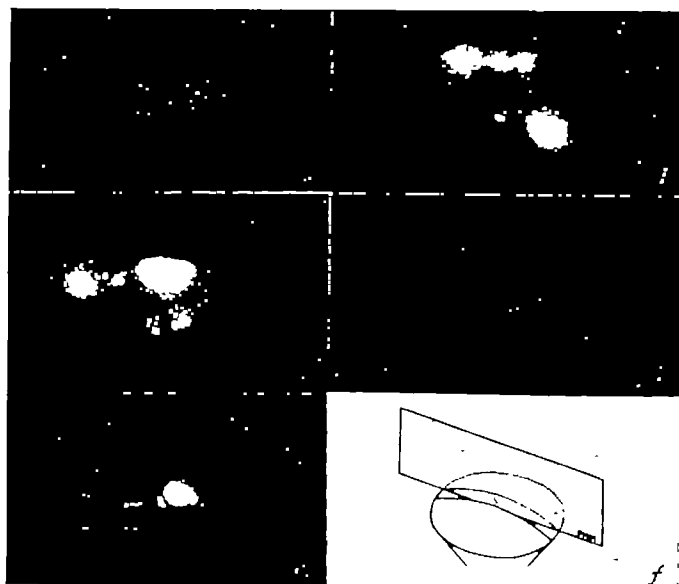


Fig. 1. Autoradiographs of radiation given off by transferred metal on screws. (a) 1st screw driven carefully, 22 μ gm. (b) 2nd screw, slight slip, 47 μ gm. (c) 3rd screw, greater slip, 65 μ gm. (d) 4th screw, extreme care, 17 μ gm. (e) 2nd screw; distribution of transferred metal within slot, the line is the edge of the film and the bottom of the slot. (f) Position of film for autoradiograph shown in e.

ferred from the driver to the screw head was calculated:

1st screw	22 μ gm.	3rd screw	65 μ gm.
2nd screw	47 μ gm.	4th screw	17 μ gm.

The distribution of the transferred metal was determined using an autoradiographic technique. In this method the radioactive particles were photographed by their own radiation on a sheet of X-ray photographic film placed against the screw head. The screws were placed head downwards on the film and the photographs shown in Fig. 1, a-d, were obtained. Each photograph shows a grey region caused by weak radiation emanating from transferred metal within the slot of the screw, while several small areas of intense whitening indicating transferred particles along the outer edges of the slots are visible in the photographs of the second and third screws.

A photograph showing the distribution of transferred metal within the slot was obtained by inserting the edge of a sheet of film into the slot of the second screw (see Fig. 1, e and f). This indicates only a little radiation emanating from the bottom of the slot, but shows several densely whitened areas corresponding to metal adhering to the outer edges of the slot.

Combining the information displayed in Fig. 1, it is possible to estimate that most of the transfer consists of a small number of discrete particles, each having a mass of a few micrograms. Most of the transferred metal is distributed along the outer edges of the slot of the screw (see Fig. 2). If more severe

conditions of screwing are used, we may expect the transfer to be correspondingly greater.

Some measurements were made of the electrode potential of these steels immersed in N/10 sodium chloride and in N/10 hydrochloric acid solutions, since this is

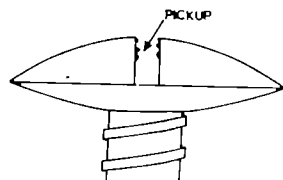


Fig. 2. Diagram of screw head, showing where adherent metal was detected.

a major factor in determining inflammation and corrosion. In each solution the steel of the driver was strongly electro-negative to that of the screw. This means that under these conditions the two steels could form an electrolytic couple with the driver steel acting as the anode. Samples of the two steels were left in the hydrochloric acid solution for two days. The screw steel showed no apparent corrosion, but the driver steel showed marked chemical attack.

Surgical observations. During operations on fractured bones which had previously been fixed with metal plates and screws, portions of the tissues in contact with the metal were removed for microscopic examination. Ten biopsy specimens were obtained. All ten specimens had been in contact with the metal for more than four months and none longer than ten months. No complicating sepsis had occurred in any of these cases. Two microtome sections were prepared from each specimen. One was stained with haematoxylin and eosin in order to demonstrate the presence of iron salts in the tissue. These salts are present only when there has been considerable inflammation.

The other was stained to detect the presence of smaller quantities of iron in and around the cells by the Prussian blue reaction. The presence of iron in the tissue indicates that corrosion has occurred. It is not in itself very harmful. It is the electrolytic reaction which interferes with the healing of the tissue.

Specimens of tissue removed from areas adjacent to the heads of the screws and bolts showed heavy iron infiltration and tissue inflammation (Fig. 3, b). Specimens removed from areas adjacent to metal surfaces which had not been handled heavily showed little iron infiltration or inflammation (Fig. 3, a). Over the period studied, the amount of inflammatory change and iron deposit did not depend markedly on the length of time the metal had been buried.

Conclusion. The presence of free iron in the tissues adjacent to the stainless steel is taken as evidence of corrosion of the metal. Such corrosion is accompanied by an 'electrolytic inflammation' which interferes with the bone union and healing. Consideration of the surgical material shows that an inert alloy can, on occasion, behave as a toxic one.

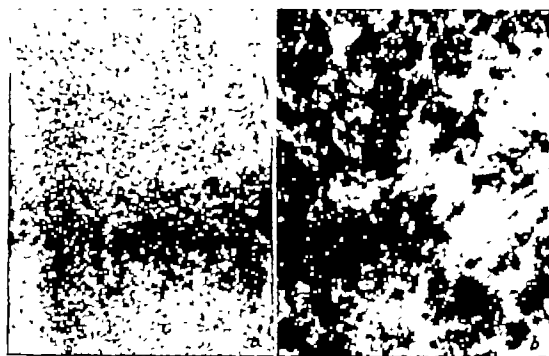


Fig. 3. Photomicrographs of microtome sections of tissue stained to show presence of iron. (a) Tissue adjacent to region of stainless steel plate which had not been handled; no iron present. (b) Tissue adjacent to region where heavy handling had occurred; heavy deposits of iron.

This occurs where the metal has been handled with screwdrivers or spanners, and is apparently more marked when the handling is severe. It is less marked when the metal has not been handled heavily.

The physical experiments show that it is almost impossible to insert a screw without leaving some fragments of metal from the driver adherent to the screw. The amount increases markedly if any slip occurs during screwing. The steel used for the plates and screws is very resistant to corrosion, but that used for the screwdrivers and spanners is not. Measurements show that an appreciable difference in electrode potential can be set up between these two steels, so that they form an electrolytic couple which may have a harmful effect on the healing of the tissue and which will act as a corrosion centre. These physical observations may therefore offer an explanation of the surgical behaviour. Other factors which may play a part are the plastic deformation of the steel and the deformation of the protective oxide layers since these can alter the electrode potential. The effect of differential transfer can be diminished by a suitable selection of the metal used both for the driver and for the screws. We find, for example, that if the screws are made of 'Vitalium' alloy the amount of the driver transferred to it is very much less.

Analogous experiments in bolting operations show that the amount of metal transferred from the spanner to the bolt head is greater than that observed in screwing.

We thank Down Bros. and Mayer and Phelps, Ltd., for gifts of medical tools and screws.

¹ Bowden, F. P., and Tabor, D., "The Friction and Lubrication of Solids" (Oxford Univ. Press, 1950).

² Venables, C. S., and Stuck, W. B., *J. Bone and Joint Surgery*, 30A, 247 (1948).

³ Fink, Colin G., "Use of Metal in Internal Fixation of Human Bone Fractures", Committee of Medical Research, U.S. Office of Scientific Research and Development (Report No. 17) (1944).

⁴ Venables, C. S., and Stuck, W. G., *J. Amer. Med. Assoc.*, 111, 1, 340 (1938).

OBITUARY

Prof. E. P. Cathcart, C.B.E., F.R.S.

EDWARD PROVAN CATHCART, whose death occurred on February 18, retired in 1947 from the regius chair of physiology in the University of Glasgow after almost half a century of continuous devotion to the study of man as a whole; yet, shortly after he first graduated in medicine in 1900, he went to Germany to study bacteriology. There he came under the influence of Voit, whom he revered as a master. At the beginning of this century direct observations on human beings were largely confined to studies of metabolic processes. Such an approach appealed to Cathcart, and his appointment in 1905 to the newly founded Grieve lectureship in physiological chemistry in his own University gave his predilection full scope. In 1907 he published two classical papers on the metabolism of protein and of inorganic elements during starvation. He used Beauté, a *Hungerkünstler*, as subject. On himself he observed the influence of carbohydrate and of fat on protein metabolism.

Cathcart travelled widely; he studied in Russia with Pavlov, whose influence is shown in the publication of two papers on the gastro-intestinal tract of dogs. Cathcart never took kindly to work on lower animals; more to his liking was his work with Benedict in the United States on energy exchange in

man during muscular exercise. Their joint monograph, "Muscular Work", which appeared in 1913, is a classic.

In 1915 Cathcart was appointed to the University chair of physiology in the London Hospital. The First World War was not a period wholly of frustration. He put his special knowledge at the service of the Armed Forces and of the country, and out of this phase arose his abiding interest in nutrition, in human food habits and in the physique of men and women. A monograph on the energy expenditure of the infantry recruit in training was written in collaboration with Lord Boyd Orr and published by H.M. Stationary Office in 1919. Many papers on similar topics appeared in the *Journal of the Royal Army Medical Corps*.

In 1919 Cathcart was invited by his own University to become the first Gardiner professor of physiological chemistry. In 1921 appeared his "Physiology of Protein Metabolism", one of the famous series of "Biochemical Monographs". Cathcart still kept alive his interest in metabolism, paying special attention to the influence of muscular work. With Markowitz he wrote a most acute analysis of the significance of the respiratory quotient, being rather impatient with the oversimplified native interpretations then current. However, a shift in the emphasis of his work gradually became apparent. Between 1924 and 1940, the Medical Research Council published five of his reports on the diets of families in different parts of Britain. Membership of the Industrial Fatigue Research Board (later Industrial Health Research Board), of which he was to become chairman during 1933-40, led to work on human physique and stature and to the appearance of two monographs, one on the physique of women in industry (1927) and another on the physique of man in industry (1935).

In 1928 Cathcart succeeded Noel Paton in the regius chair of physiology in the University of Glasgow. In his later years committee work and administration made increasingly heavy demands on his time; his colleagues in the Physiological and Biochemical Societies saw progressively less of his spare dynamic figure. Yet he kept alive his interest in the implications of physiological knowledge for social welfare, he did some little work on psychology, and his last scientific publication in 1948 dealt with histological work on the innervation of the nipple.

Cathcart's work, in spite of its seeming diversity, was all of a piece. His early studies on metabolism, on the alimentary canal and on energy exchange in man led on smoothly to his later work with its wide social implications.

Without being reactionary, Cathcart had yet a sceptical habit of mind. The new and the novel in physiology and in social science had less appeal than the established facts and accepted attitudes of the past. Facts were naturally sacred; but comment, he felt, ought not to be too free in view of our essential ignorance of the functioning of the integrated organism as a whole. Thus Cathcart resisted what he regarded as excessive emphasis on the importance of vitamins and of 'minerals' in nutrition; 'nature' to him was as important, if not more important, than 'nurture'. Yet he was a most stimulating teacher, in his personal relations he was kindly and sympathetic, and he went to endless pains to encourage and to help young workers. It is to be doubted if we shall see again anyone so well versed in the broad principles of human biology.

R. C. GARRY

NEWS and VIEWS

Physical and Inorganic Chemistry at Bristol:

Prof. W. E. Garner, C.B.E., F.R.S.

PROF. W. E. GARNER is retiring after twenty-seven years from the Leverhulme chair of physical and inorganic chemistry in the University of Bristol, to which he was appointed in 1926, in succession to the late Prof. J. W. McBain. Prof. Garner's energy and outstanding ability have been devoted to the well-being of the Chemistry Department and research, and to the fostering of collaboration between different departments of the University and between his Department and industry. He created the inter-departmental honours school of biological chemistry in 1950. During the Second World War the resources of the Chemistry Department were marshalled for explosives research, and Prof. Garner whole-heartedly applied himself to national work, becoming temporarily, in 1944, chief superintendent of armaments research at Fort Halstead. His researches have been typically broad. He has made valuable contributions to the study of flames and of explosions in gases and solids. His pioneer work on nucleation and decomposition of azides and hydrates, and on the relations between the physical properties and the chain lengths of aliphatic compounds, is of fundamental importance. Work on the surface chemistry of solids, and on the heat and kinetics of adsorption, developed later into an intensive study of oxide catalysts. He was elected to the Royal Society in 1937, made president of the Faraday Society in 1946 and pro-vice-chancellor of the University of Bristol in 1952. Students and colleagues of Prof. Garner have all been inspired by his enthusiasm and insight, and he has always been approachable by even the most junior. Scrupulous fairness, talent for securing willing co-operation, and his ability to put first the real interests of others, have made his Department a most happy one.

Prof. D. H. Everett, M.B.E.

PROF. D. H. EVERETT, professor of chemistry since 1948 at University College, Dundee, in the University of St. Andrews, has been appointed to succeed Prof. W. E. Garner in the Leverhulme chair at Bristol. Prof. Everett received his scientific training in the University of Reading, and his first researches were done there and at Dundee under Prof. W. F. K. Wynne-Jones. In 1939 he went as a Ramsay Fellow to work on reaction kinetics under Mr. R. P. Bell at Balliol College, Oxford, but after a short time joined Sir Cyril Hinshelwood's research team working for the Ministry of Supply. From 1942 until the end of the War he was attached to the War Office and undertook scientific liaison missions to the Middle and Far East. Prof. Everett returned to Oxford as an Imperial Chemical Industries Fellow, and in 1947, after a short period as lecturer in Dundee, was elected to an official fellowship at Exeter College, Oxford. He was appointed to the chair in Dundee in 1948, and during the past six years he has supervised the extension and re-equipping of the Chemistry Department and has established a vigorous research school which is working on the thermodynamics of acid-base equilibria, the electrochemistry of non-aqueous solutions, reaction kinetics, the thermodynamics of adsorption, and the phenomenon of physico-chemical hysteresis. He has also translated and revised Prigogine and Defay's "Chemical Thermodynamics", which is to be published very shortly.

Geology Division of the Anglo-Iranian Oil Co., Ltd.:

Dr. G. M. Lees, F.R.S.

DR. G. M. LEES has retired from his appointment as chief geologist of the Anglo-Iranian Oil Co., Ltd. He had a distinguished record in the First World War with the Royal Flying Corps, winning the Military Cross and the Distinguished Flying Cross, and later served as an assistant political officer in Southern Kurdistan. He joined the Anglo-Iranian Company in 1921 and his early work lay in south-west Persia and Oman; he was awarded a doctorate of philosophy in the University of Vienna for his researches in Oman. He was appointed chief geologist to the Company in 1930 at the age of thirty-two and thereafter worked in many different parts of the world. It was a period of intensive exploration and development; in all this Dr. Lees played an important part, demonstrating remarkable geological knowledge and a shrewd appreciation of practical problems. It was he, too, who inspired the search for oil in Great Britain which led to the discovery and exploitation of oilfields in Nottinghamshire. In 1943 he was awarded the Bigsby Medal of the Geological Society of London and in 1948 was elected a Fellow of the Royal Society. He was president of the Geological Society in 1951 and 1952. It is noteworthy that in his presidential addresses, delivered with his customary skill in exposition, he was concerned with fundamental concepts in geology, bringing to bear upon them the knowledge and experience gained in many countries. His work has always shown the essential unity of pure and applied science.

Mr. P. T. Cox, M.B.E., and Mr. N. L. Falcon

FOLLOWING Dr. Lees's retirement, Mr. P. T. Cox has been appointed chief geologist and exploration manager of the Anglo-Iranian Oil Co., and Mr. N. L. Falcon manager of the Company's geological division. Mr. Cox is a graduate of Canterbury University College, Christchurch, New Zealand, and after a short period on the Geological Survey of that country joined the Anglo-Iranian Oil Co. in 1924. He has worked in many countries, notably Peru, Venezuela, Colombia and the Middle East. He made a special study under Prof. Douvillé in Paris of Foraminifera, so important in oilfield geology. He was associated with Dr. Lees in the search for oil in Great Britain, and joint author with him of a paper on the geological basis of that search. He served with the Royal Engineers during the Second World War and was made M.B.E. He returned to Persia after demobilization and became general manager of the Company's oilfields there in 1948.

Mr. Falcon joined the Anglo-Iranian Oil Co. in 1927 after graduation in the University of Cambridge. He served in Persia until 1936, undertaking extensive geological surveys as well as oilfield development. Later he took part in the exploration drilling programme in Great Britain and became increasingly interested in the applications of air photography to geology. He served in the Intelligence Corps during the Second World War, his duties including the study of air photographs, and he was awarded the United States Bronze Star. Since the War, he has been concerned with a wide range of geological problems in Great Britain, Europe and the Middle East. He is author or joint author of papers on various subjects such as gravity-alip phenomena in Persia and the results of geophysical surveys in England.

Einstein Award : Dr. R. P. Feynman

THE third Einstein Award was made on March 14, the seventy-fifth birthday of Prof. Albert Einstein, to Dr. Richard Phillips Feynman, of the California Institute of Technology. This Award, which was established in 1950 by the Lewis and Rosa Strauss Memorial Fund, consists of a gold medal and fifteen thousand dollars, and the recipient is selected by a committee at the Institute for Advanced Study, Princeton, where Prof. Einstein works. The two previous Awards have been made to Dr. Julian S. Schwinger, of Harvard University, and Dr. Kurt Godel, of the Institute for Advanced Study. Dr. Feynman, who is a graduate of the Massachusetts Institute of Technology, received his degree of Ph.D. from Princeton University in 1942 and was professor of physics in Cornell University during 1945-48. The main field of his research is quantum mechanics and, particularly, quantum electrodynamics. Both among the results and among the concepts in the latter field, some of the most important work developed during the past decade is due to him. In this respect, his treatment of quantum mechanics by the probability amplitude method, and the development of what is known as the Feynman diagram in accounting for possible particle transformations, are especially noteworthy.

Textile Institute : Awards

HONORARY fellowship of the Textile Institute has been conferred on Prof. S. C. Harland, George Harrison professor of botany in the University of Manchester. Prof. Harland, who is the eleventh recipient of this honour, the highest that the Institute can bestow, is responsible for many notable advances in the volume, quality and stability of cotton crops throughout the world as a result of his work in plant breeding and genetics in the Sudan, the West Indies, Brazil and Peru, as well as in Great Britain. Other awards of the Institute have been made as follows : *Institute Medal*, to Mr. W. Howarth (general manager, Muesgrave Spinning Co., Ltd.) and to Dr. C. S. Whewell (reader in textile finishing, University of Leeds) in recognition of distinguished service to the textile industry in general and to the Institute in particular ; *Service Medal* to Mr. J. O. H. Hurd (head of the Textile Department, Leicester College of Technology) for valuable services rendered to the Institute.

Chemical Technology In Edinburgh : New Chair and Department

APPROVAL of the promotion of ordinances for the foundation of a chair of chemical technology and for the institution of a new degree of bachelor of technological science (B.Sc. Technological) has been given by the University of Edinburgh. This decision, taken after consultation with the Heriot-Watt College, Edinburgh, marks the joint response of the University and the College to the urgent need for an increased supply of trained technologists. Both institutions are already making substantial contributions to the demand for training in applied science, and the proposed extension in what has come to be accepted as the fourth main branch of engineering industry is notably appropriate in view of local and national developments in the chemical industry. The new Department of Chemical Technology will be housed in the Heriot-Watt College, where ample provision for it has been made in the extension of the College premises now under con-

struction. The new professor, although occupying the University chair, will act as head of the new Department in the College. The University has agreed to transfer to the College all the equipment in its Sub-Department of Technical Chemistry. The joint arrangement proposed provides a scheme whereby the requirements for the training of University and College students in this field may be met without duplication of effort. It is proposed to make a joint appeal to the appropriate firms in Scotland and elsewhere for contributions towards the endowment of the chair and for suitable equipment to be used for teaching purposes.

New Chairs at the University of Nottingham

IN commemoration of the long and distinguished services of Lord and Lady Trent, the Boots Pure Drug Co., Ltd., has given to the University of Nottingham the sum of £100,000 for the endowment of two new professorial chairs to be known as the Lord Trent chair of pharmaceutical chemistry and the Lady Trent chair of chemical engineering. The announcement of this generous benefaction was made at a special meeting of the Court at which the University accepted with deep regret the resignation, necessitated by continued ill-health, of Lord Trent from the office of chancellor. Lord Trent became a member of the University College Council in 1923 and was later chairman and president. By the charter of incorporation of the University granted in 1948 he was created chancellor. Until his recent retirement he had been since 1931 chairman of the Boots Pure Drug Co., which in 1949 contributed £50,000 to the University's endowment appeal. The natural interest of the Company in the development of chemistry found its expression so long ago as 1921 when, as Sir Jesse Boot, the first Lord Trent, to whose munificence the University owes its principal buildings at University Park, endowed the Sir Jesse Boot chair of chemistry. In founding a chair of pharmaceutical chemistry the Company has indicated its desire to encourage the study of pharmacy and the development of research. The endowment of a chair of chemical engineering, following the recent institution of the Cripps chairs of metallurgy and of production engineering (*Nature*, December 19, p. 1129), will materially aid the University in its plans for the further development of the technological sciences.

Year Book of the Royal Society

THE recently issued Royal Society "Year Book" (pp. 311 ; from the Royal Society, Burlington House, London, W.1 ; 1954 ; 15s.), like its predecessors, is a volume which, apart from its usefulness as a work of reference, is a book to be dipped into for the host of scientific items—some important and some less so, but all interesting enough—which are to be found among its pages. The lists of Fellows and foreign members occupy the first fifty pages and give their appointments, postal addresses, year of election to the Society, awards by the Society and service, if any, on the Council. It is interesting to note from these lists that there are four Fellows who were elected more than fifty years ago. The remaining five-sixths of the book is so full of miscellaneous information regarding the membership of the many types of committee and board, standing orders, procedure for the council, medal awards, lectures, financial trusts and funds, special fellowships and appointments, that even the listing of these items is a lengthy affair. One revealing

point emerges from these pages, namely, the way in which the Society is advised on the various branches of science by means of its sectional committees. These are eight in number and are as follows: mathematics; physics; chemistry; engineering sciences; geology; botany; zoology; and physiology and medical sciences. The first six have nine members each and the last two twelve. It is worth noting that the full title of the Royal Society is the Royal Society of London, for Improving Natural Knowledge. The fact that it exists for improving natural knowledge is a *sine qua non*; the "of London" would seem to-day to be merely significant of the *venue* of its meetings, for the Society is the premier national scientific body, being open to all members of the British Commonwealth and the Republic of Ireland.

The Piltown Flints

At a meeting of the Geological Society held at Burlington House on February 24, Mr. A. T. Marston exhibited a number of flints which he had attempted to stain with chromic acid or potassium dichromate in order to assist appreciation of the condition of the Piltown flint recently described by Drs. Oakley and Weiner (*Nature*, December 12, 1953). Mr. Marston pointed out that though some of these flints would not stain at all, others became deeply stained. In the latter case, however, the stain was very difficult to remove. As the stain on the Piltown flint had apparently been easily removed by acid, Mr. Marston queried whether it had indeed been artificially produced, and also inquired whether there was any possibility that traces of chromium might exist naturally in the ferruginous Piltown gravels. Dr. Oakley then exhibited specimens of flint from Piltown, and described tests that had been made on all the flints illustrated in the original paper by C. Dawson and A. Smith Woodward. All these flints had a ferruginous stain which was easily removed by acid, in contrast to other "natural" flints from the Piltown area collected at the same time, which had a heavy ferruginous stain that was not removed by acid. In one of the flints illustrated in the original paper (B.M.(N.H.) E. 606), the presence of chromium had also been demonstrated. Dr. Oakley believed that the illustrated flints had been stained artificially with a ferruginous solution, and in one case a chromic solution had also been used in order to make the flint less red, and so resemble more closely the "natural" flints.

New Journal of the Medical Faculty of Zagreb

A new and attractively produced journal entitled *Radovi Medicinskog Fakulteta u Zagrebu* (Vol. 1, pp. 146+7 plates; 1953) has been started by the Medical Faculty of Zagreb, under the direction of Prof. F. Kogoj. It contains articles on a variety of subjects, most of which have summaries in English or French. Drs. B. Gušić and Z. Kraljina write on otitis of suckling infants, and Dr. B. Milojević on his experience of the treatment of chronic suppurative otitis media by the endaural approach to the middle ear, an operation for which it is claimed that it shortens the period spent in hospital and makes possible direct approach to the middle ear cavity; so that the structures of this part of the ear are preserved and most cases recover their hearing. Drs. Lj. Bežović and L. Rabadžija discuss the reactions of the eosinophil blood cells in rats adapted to adrenalin and histamine, and Drs. J. Vesenjak-Zmijanac and V. Beličević report on influenza in

Zagreb during 1950-51. Dr. N. Allegretti considers the function of the insular apparatus and insulin in relation to the anterior lobe of the pituitary gland, the thyroid and the adrenal cortex, and Drs. E. Rosenzweig and F. Zernsky discuss about eighty-eight cases of brow-presentations at birth. An article by Dr. V. Bezjak on the classification of fungi isolated from man in Zagreb is the first report on these organisms in Yugoslavia. The early diagnosis and modern therapy of malignant tumours of the upper jaw and nose is discussed by Drs. B. Pegan and M. Špoljar; Dr. A. Brnobić writes on the etiology of two cases of professional allergic eczema, one caused by silkworm larvae, and Dr. Z. Jurin-Mratović on the treatment with penicillin of seventeen cases of scleroderma and chronic acrodermatitis. The good wishes of medical men will readily go to this promising new journal. The language difficulty will probably restrict its usefulness in Britain; but the English and French summaries give the gist of the articles, and those who wish to read them in full can probably arrange to have them translated.

Society for the Bibliography of Natural History

THE annual general meeting of the Society for the Bibliography of Natural History was held at the Geological Museum, London, S.W.7, on March 4. Mr. V. A. Eyles addressed the meeting on "Bibliography and the History of Science". The first part of the third volume of the Society's *Journal* was issued at the end of December 1953, containing ten articles, of which one is an appreciation of the late Dr. C. Davies Sharborn, first president of the Society. The following were elected officers of the Society: *President*, Dr. J. Ramsbottom; *Hon. Secretary and Treasurer*, Mr. A. O. Townsend, British Museum (Natural History), London, S.W.7; *Management Committee*, A. G. Davis, W. N. Edwards, F. C. Fraser, F. J. Griffin, W. T. Stearn, C. Kirke Swann.

Physical Society Exhibition

THE Physical Society's thirty-eighth Annual Exhibition of Scientific Instruments and Apparatus will be held in the Imperial College of Science and Technology, South Kensington, London, S.W.7, on the following dates: April 8, 9 and 12, 10 a.m.-8 p.m.; and April 10 and 13, 10 a.m.-5 p.m. The morning of April 8 (10 a.m.-2 p.m.) will be reserved for Fellows of the Society and the press only. This year the Exhibition is confined to the main building of the College, Imperial Institute Road. Three discourses (each at 6.15 p.m.) will be given as follows: April 8, "Electrical Contacts", by Prof. F. Llewellyn Jones; April 9, "An Artificial Talking Device", by Mr. W. Lawrence; and April 12, "The Study of Surface Micro-topography by Optical Methods", by Prof. S. Tolansky. Orders for the usual "Handbook" (6s., or 7s. 3d. by post) and all matters relating to the Exhibition should be addressed to the Physical Society, 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

Society for Analytical Chemistry

THE eightieth annual general meeting of the Society for Analytical Chemistry was held on March 3 in London, when the financial statement and report of the Council for the past year were submitted and approved. The membership of the Society was reported as being 1,646, an increase of 54 since last year. In addition to the eight ordinary meetings of the Society (six in London and one each in Glasgow

and Southampton), eighteen meetings were held by its Sections and Groups during the course of the year. At the conclusion of the meeting, the Bernard Dyer Memorial Lecture of the Society was given by Dr. E. B. Hughes, who spoke on "The Contribution of Public Analysts and Other Analytical Chemists to Public Welfare". The following officers and members of council were elected for the forthcoming year: *President*, D. W. Kent-Jones; *Past Presidents serving on the Council*, Lewis Rynon, G. W. Monier-Williams, J. R. Nicholls and G. Taylor; *Vice-Presidents*, O. A. Adams, A. J. Amos and T. McLaughlan; *Honorary Treasurer*, J. Hamenoe; *Honorary Secretary*, K. A. Williams; *Other Members of Council*, D. C. M. Adamson, A. L. Bacharach, R. O. Chirnside, Miss M. Corner, D. O. Garratt, J. Haslam, C. L. Hinton, H. W. Hodgson, H. M. N. H. Irving, A. G. J. Lipscomb, R. E. Stuckey and O. Whalley; *Ex-Officio Members*, T. W. Lovett (chairman of the North of England Section), R. S. Watson (chairman of the Scottish Section), A. M. Ward (chairman of the Microchemistry Group), A. A. Smales (chairman of the Physical Methods Group) and L. J. Harris (chairman of the Biological Methods Group); *Honorary Assistant Secretary*, N. L. Allport.

Garth Field Studies Centre

THE Garth Memorial Youth Hostel and Field Studies Centre (by Aberfeldy, Perthshire) is situated among fine Scottish mountain scenery and countryside which give excellent opportunities for work in zoology, botany, geology, geography and archaeology. Certain rooms in Garth House are occupied by the Scottish Field Studies Association, among which are a library-lecture room and a small laboratory. Accommodation is available for individuals and for parties up to 30-40. This year, the warden (Mr. F. N. Haynes) will conduct two courses on the botany of the area (July 10-17 and 24-31). Further information can be obtained from the Joint Honorary Secretary, Scottish Field Studies Association, Department of Botany, The University, Glasgow, W.2.

University Visitors to Great Britain

THE Association of Universities of the British Commonwealth (5 Gordon Square, London, W.C.1) publishes a list of "Academic Visitors to the United Kingdom", based principally on information furnished by the registrars of member universities and university colleges in overseas parts of the British Commonwealth. Copies are circulated to universities, learned societies and other interested bodies in the United Kingdom with the view of assisting them, if so desiring, to make contact with current or prospective visitors. Copies can be obtained on request. The list, which gives the name, university and post for each entry, is divided into two parts: visitors already in Britain, with approximate date of departure; and non-professional staff of Colonial Institutions spending their long vacation in Britain, with approximate dates.

Announcements

SIR ALEXANDER FLEMING, emeritus professor of bacteriology in the University of London, has been elected a foreign associate of the Paris Academy of Sciences in succession to the late Prof. M. Lugeon. Prof. Léopold Escande, professor of the mechanics of fluids in the University of Toulouse, has been elected a non-resident member of the Academy in

succession to the late Prof. E. Bataillon. Prof. Gabriel Foëx, professor of experimental physics in the University of Strasbourg, has been elected *correspondant* for the General Physics Section in succession to Prof. L. Néel, recently elected a non-resident member.

MR. A. G. PHACOCK, secretary of the Scientific Instrument Manufacturers' Association, has resigned and joined the board of Mervyn Instruments, St. John's, Woking, Surrey. He is well known as the honorary exhibition secretary of the Physical Society.

PROF. RAGNAR GRANIT, director of the Nobel Institute for Medicine, Stockholm, will give the Silliman Lectures this year, his subject being "Receptors and Sensory Perception". The Lectures, which are open to all those interested in neurophysiology, psychology, psychiatry and related fields, will be given in Yale University on April 29 and 30 and May 3, 4, 5, 6 and 7. They mark the fiftieth anniversary of the first Silliman Lectures on "The Integrative Action of the Nervous System", given in 1904 by the late Sir Charles Sherrington.

COMMONWEALTH Fund fellowships for members of the United Kingdom Home Civil Service to study in the United States during 1954-55 have been awarded to the following: A. Currall (Ministry of Materials), D. W. Davies (Department of Scientific and Industrial Research) and L. E. J. Roberts (Atomic Energy Research Establishment). Similar fellowships for those in the Colonial Civil Service have been awarded to A. L. C. Thorne (Nigeria) and K. J. Henderson (Federation of Malaya).

THE Chemical Society is offering a Corday-Morgan Award for 1953, consisting of a silver medal and a monetary prize (150 guineas), which will be made to the British chemist who published during 1953 the most meritorious contribution to experimental chemistry, and who, at the date of publication, had not attained the age of thirty-six years. Applications or recommendations in respect of the Award must be received not later than December 31, 1954. Further information can be obtained from the General Secretary of the Society, Burlington House, London, W.1.

THE Colorado School of Mines, Golden, Colorado, is offering a tuition scholarship to a male student from England for the academic year 1954-55. The scholarship, which is renewable for a maximum period of four years, carries exemption from tuition fees (about 425-475 dollars a year) but does not cover student's fee or personal expenses (about 80-110 dollars a month). Further particulars may be obtained from the Cultural Affairs Officer, American Embassy, 41 Grosvenor Square, London, W.1, or from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1. Applications must be sent to the latter by May 1.

As part of the Tenth International Congress of Agricultural and Food Industries, to be held in Madrid during May 30-June 6 (see *Nature*, February 20, p. 389), the International Federation of Fruit Juice Producers is holding its third international congress, which will take place during June 1-2. Persons in Great Britain who wish to attend should write to the Apple Juice Producers Association of Great Britain, 8-9 North End, Wisbech, Cambs, from which further information can be obtained.

DEEP-SEA RESEARCH

SEVEN papers, a foreword and a brief note on a symposium held in the Jane Hardman Geology Laboratories of the University of Liverpool during September 1-2, 1953, constitute the first number of a new scientific quarterly journal, *Deep-Sea Research**, sponsored by the Joint Committee on Oceanography of the International Council of Scientific Unions. All contributions deal essentially with the floor of the oceans, in accordance with the terms of reference of the sponsoring body, namely, "that its work should be restricted to the investigation of the deep-sea floor". The title of the journal tends, therefore, to be misleading, especially if, as seems to be indicated, its policy is to remain focused on deep-sea floor problems and research, the emphasis being mainly geological rather than oceanographical except by contingency. A title such as "Deep-Sea Floor Research" would thus appear more accurately to express the substance and intention of the journal, and would be more likely to attract those, besides oceanographers, to whom its contents would be of greatest concern and interest.

In the first article, on "International Collaboration in Deep-Sea Research", Dr. J. D. H. Wiseman (London), president of the Joint Commission on Oceanography, cites the complexity of the problems to be solved, together with the high cost of equipping and maintaining oceanic research expeditions, as the case for the practical necessity of international collaboration in such work, an essential prerequisite of which are accurate bathymetric charts of the sea-bed. Those produced by the International Hydrographic Bureau, Monaco, and collectively styled "General Bathymetric Chart of the Oceans", are commended provided they can be re-edited every five years. Dr. Wiseman suggests that if these charts were more widely known for their artistic and other qualities, not only among scientific workers, but also to librarians and shipping companies, they would soon become largely self-supporting. The paper further deals with recent scientific developments in deep-sea floor research; for example, the invention by Dr. B. Kullenberg (Sweden) of a new long-core (20 m.) bottom sampler¹, enabling the acquisition of unrivalled material for the study of historic and also pre-historic climatic changes; the evolution by Belgian and Swedish scientists, working in collaboration, of a new method for determining the rate of sedimentation on the sea floor; the rapid improvement in our knowledge of submarine topographical features by the aggregate efforts of a number of American submarine geologists working in conjunction with the United States Navy and Coast and Geodetic surveyors; the accurate measurement of the rate of heat-flow through the deep-sea floor by a co-operative effort of British and American scientific workers; and a number more. Of such promise, indeed, to the Joint Commission on Oceanography is the prospect of realization within a reasonable time of "a new level of understanding of deep-sea problems", consequent upon developments in electronics, physics, chemistry, methods of detailed surveying and sampling of the deep-sea floor; and recognising the virtual necessity of international collaboration in investigations to that end, Dr. Wiseman gives it as the express intention of the Commission to explore the possibility of

establishing a permanent, non-governmental bureau or council to act as an advisory and promoting organisation for the conduct of deep-sea floor and contingent investigations. In this, one may be disposed to be sceptical of the necessity to establish yet another body, especially a permanent one, for purposes which perhaps a judicious modification or extension of the terms of reference of existing organizations, national or other, might well and sufficiently include.

A second paper, by Dr. Wiseman and Mr. C. D. Ovey, the secretary of the above-mentioned Joint Commission, usefully sets out a list of approved and defined terms, with a statement of agreed principles to govern nomenclature, which it is proposed should be applied to deep-sea topographical features. Some of the terms, such as 'continental borderland', 'borderland slope', 'seascarp', 'seahigh', 'seamount', 'tablemount', 'seapeak' and 'seaknoll' are new; and the list, which is largely the work of the British National Committee on the Nomenclature of Ocean Bottom Features, set up under the corresponding International Committee of the International Association of Physical Oceanography, is now published in order to test the degree of universal acceptance and employment of the terms before the parent Committee promulgates its decisions. These terms, if universally approved and adopted, would, by the introduction of systematic nomenclature on the lines proposed, obviate much future confusion and ambiguity in the specification of oceanic bathymetric features.

Prof. Hans Pettersson (Sweden), in a third paper, gives a summary account of the origin, aims and principal results of "The Swedish Deep-Sea Expedition, 1947-48", which he was chiefly instrumental in instigating and carrying through to a successful conclusion. The main work of this fifteen-month circumnavigating enterprise on the 1,450-ton motor-schooner *Albatross*, loaned by the shipping firm of Broström and Co., Gothenburg, before being put into service as a training-ship, centred around Kullenberg's long-core bottom sampler operated at great depths, the record depth at which a long core was taken being 7,500 m. Bottom profile records to more than 7,000 m. were also made, revealing that, in these abyssal regions, as in lesser depths, 'flat areas of practically uniform soundings are the exception rather than the rule. As Prof. Pettersson points out, this new fact raises important questions regarding the dynamics, tectonic and volcanic, of the deep-sea floor, and implies replacement of the former conception of a vast sea-floor peneplain due to age-long uninterrupted sedimentation smoothing out any original ruggedness in the rocky substratum, by that of a constant 'resculpturing' of the ocean bed, producing abrupt differences in level. New techniques, methods and means, some of them devised during, and by members of, the expedition, were employed in the measurement of the thickness of the bottom sediment, in determining bottom water movements in very deep water by study of its optical properties and the prevalence and stratification of suspended particles, and in the taking of undisturbed water samples quite near to the bottom. Large quantities of water were collected and preserved for uranium and radium measurements, and trawling operations were carried out at great depths in the North Atlantic Ocean to study the abyssal fauna. It is hoped that

* *Deep-Sea Research*, 1, No. 1, October 1953. Pp. 64. (Published quarterly by the Pergamon Press, Ltd., 243 Marylebone Road, London, N.W.1.) 34 4s. a vol. or 24s. a number.

at least the essential scientific results of the expedition, some of which have already appeared, will be published before the end of 1956.

The next paper is a contribution by B. C. Heezen, M. Ewing and E. T. Miller, of the Lamont Geological Observatory of Columbia University, New York, and deals with a "Trans-Atlantic Profile of Total Magnetic Intensity and Topography, from Dakar to Barbados". Early flights over marine areas with an airborne magnetometer indicated that correlation might exist between topographical features and the character of the magnetic field. By enclosing this instrument in a non-magnetic, streamlined, water-proof case, and towing it behind a ship, magnetic surveys of oceanic areas have become possible without the use of specially constructed, non-magnetic vessels, and the above authors give an account of such a survey across the Atlantic in 1948, when west of Dakar for 170 miles the magnetic field was found to be smooth with anomalies of less than 25 gammas. Anomalies of 50 to more than 200 gammas, 5-40 nautical miles in width, were encountered from the Cape Verde Islands region to Barbados. The topographical contrast between the deep ocean basins and the Mid-Atlantic Ridge was not reflected in the anomaly curve, while large anomalies observed over the submerged parts of the Cape Verde Islands showed the effect of known volcanic islands. No such anomaly was observed near Barbados, or over the continental margin of Africa.

A paper follows by F. Bernard on the role of calcareous flagellates in deep-sea fertility and sedimentation, as shown by recent work in the Atlantic Ocean and in the Western Mediterranean. Coccolithophorids were found to be the chief subscribers to sedimentation to depths of at least 4,000 m., the total volume of calcareous flagellates generally amounting to more than 50 per cent, and often 95 per cent, of the phytoplankton in the bathypelagic zone.

Dr. Wiseman and N. Hendry, from a unique bottom sample collected by H.M.S. *Challenger* in 1951, write on the significance and diatom content of a deep-sea floor sample from the neighbourhood of the greatest oceanic depth. The sample was from a depth of about 10,505 m. at a position about five miles from the greatest known oceanic depth in the Marianas Trench* and was taken by means of a Baillie rod. The position was about 60 nautical miles west of that at which, during her classical voyage of 1872-76, the former H.M.S. *Challenger* took a similar sample in about 8,185 m. The two samples were similar in colour and of proportionately the same amounts of organically produced silica; but differed in the proportions of the organisms present, the earlier material being almost entirely composed of radiolarians with few diatom fragments, while approximately 4 per cent of the recent sample consisted essentially of diatoms with minor amounts of radiolaria. There was clear evidence of erosion, the authors state, in electron microscope photographs of the 1951 sample. In conclusion of this article, the geomorphological relations and some of the problems of deep-sea trenches are discussed.

The concluding article to this interesting number of the new journal is one giving further notes on the greatest oceanic sounding and the topography of the Marianas Trench, by Dr. T. F. Gaskell, J. C. Swallow and Commander G. S. Ritchie. J. B. TAIT

THE TRAVELLING SCHOLAR IN EUROPE

BRITISH COUNCIL ACTIVITIES

THE report which the British Council has issued*, with a foreword by Sir David Hughes Parry, on a co-operative experiment in academic interchange between the universities of the United Kingdom and those of certain other European countries is a fitting complement, alike to the recent report on the Fulbright Programme (see *Nature*, 173, 1; 1954) and to the discussions on academic interchange within the British Commonwealth at the Congress of Universities of the British Commonwealth last July. The experiment began as the product of a cultural convention in 1946 between the Governments of the United Kingdom and of Belgium, and the British Council was designated as the principal agent of the British Government in the joint administration of the mixed commissions established to further the aims of this and similar conventions concluded between the United Kingdom and seven other European countries. The British Council entrusted its responsibility for carrying out recommendations regarding university interchange to its Universities Advisory Committee, with Sir James Mountford as chairman; but in 1950 a special standing committee, under the chairmanship of Sir David Hughes Parry, the vice-chancellor of the University of London, was constituted to deal with proposals for foreign university interchange.

As a result of discussions with representatives of universities and education authorities in seven European countries, it became clear that there was a widespread demand throughout Europe for the re-establishment and increase of academic contacts with the United Kingdom, and that two main types of visit were required: the short visit of a few days to a week to enable scholar to meet scholar for the exchange of ideas, to give one or two formal lectures or to participate in colloquia; and the longer teaching visit of up to a term in length. More recently, Belgium has voiced a desire for the interchange for short periods of younger university scientists who have not yet achieved an international reputation. Concentrating first on the short visit by teachers of established reputation, an agreed Foreign University Interchange Scheme with Belgium came into operation in 1948. This was followed by similar arrangements with the Netherlands and Norway in 1949; with France and Austria in 1950; with Western Germany, Italy, Spain, Sweden and Switzerland in 1951; and with Finland and Portugal in 1952; arrangements were also concluded with Yugoslavia for an interchange scheme to commence in the academic session 1953-54. In all, the Scheme provides for a total of fifty-four visits to United Kingdom universities from thirteen countries each session, and for a like number of visits by British university teachers to universities in these countries.

Since the first Scheme came into operation in 1948, 252 such visits have taken place between universities in the United Kingdom and in the other participating countries. While the principles of procedure vary

* University Interchange Between the United Kingdom and Other European Countries, 1948-1953. (A Report on Reciprocal Schemes which are in Operation Between the United Kingdom and Other Countries in Europe, for the Promotion of Interchange Visits by University Teachers, and for the Award of Scholarships.) Pp. 24. (London: The British Council, 1953.)

† See *Nature*, 145, 306 (1940).

‡ See *Nature*, 156, 601 (1953).

slightly from one country to another, it has been proved that academic interchange can be organized centrally without undue threats to university autonomy and with economy in the administrative organization necessary. It is also clear that the short-period interchange visit meets a real need: no fewer than two hundred nominations are now received each year from United Kingdom universities for the incoming visits, and the number of invitations extended to British scholars by foreign universities leaves no doubt that the value of such visits is recognized just as fully by the other participating countries. Although some universities have independent schemes of their own which contribute to the total of interchange visits, it can be said that the Foreign University Interchange Scheme plays a substantial part in the renewal and furthering of academic contacts, with all that such contacts imply for international understanding and the advancement of knowledge.

Limited experiments have also been made in the provision of longer teaching visits. There are now four travelling lecturers attached to the French Institute in London who give regular courses at universities in the United Kingdom, and the British Council has to some extent met requests from abroad for similar teaching visits by British lecturers. Eight teaching visits for a month or more have been paid by British university teachers to universities in Austria, Finland and France. While the value of the longer teaching visit has been amply demonstrated, the reduction of the British Council's grant-in-aid has necessitated the termination of such visits for the time being.

On a different level, the interchange of students for postgraduate study has also become well established as a two-way traffic. For a number of years the British Council has offered scholarships tenable in the United Kingdom to students from other countries throughout the world. During the five academic sessions under review, 410 awards have been made, mostly for postgraduate study at a university for one year, to students from European countries with which reciprocal scholarship schemes are in operation. In reciprocation, foreign governments and universities are now offering annually for postgraduate study in fifteen European countries more than a hundred such awards to British students, mostly for one year; and the British Council has been asked by these governments and universities to assist in the administration of the scholarships, and usually to arrange with the Universities Advisory Committee for convening selection boards to recommend suitable candidates. The large number of applications received indicates that the facilities are fully appreciated on both sides.

There are also certain direct exchange arrangements between universities in the United Kingdom and in other European countries, and scholarships and fellowships offered by individual universities add to the total volume of student interchange. While the immediate results of interchange at this level may be less apparent than with interchange at the teaching level, the first-hand experience gained provides a valuable cultural link between the United Kingdom and other countries. On the evidence of this report alone, reductions in the British Council's grant-in-aid, which compel the interruption of such interchange at all levels, are scarcely sound economy.

There is a further reason why the Government should take care to ensure that the British Council

has sufficient financial resources to further interchange schemes on a reasonable scale. In December 1953, the Committee of Ministers of the Council of Europe signed in Paris five conventions, the most important of which will materially help young people from any of the sixteen member States in seeking admission to the universities of any of the others. The Convention commits the governments to the acceptance of international standards, but gives no guarantee of admission to a university, although the foreign student may be spared some troublesome examination when making application for admission.

The treaty powers are required to report progress in a year's time. No British Government either could or would attempt to dictate to the universities regarding the conditions or qualifications which the universities accept for admission, though British universities have been very unwilling to promise acceptance of equivalent qualifications of studies from outside the Commonwealth and the United States. Exceptions are in practice frequently granted, but both foreign students and officials are often perplexed by the apparent anarchy of regulations and variations from one university to another through which the wandering scholar has seldom shown much skill in finding his way. While the Government may well, particularly in view of the discussions at the Universities' Congress in July, expect the universities to give proof that they can really unite to make things easier for the individual student or scholar—who after all is nearer the wandering scholar or student of the Middle Ages than those whose movements are formally organized in interchange schemes—the Government must at least set the example of seeing that no short-sighted parsimony curtails what is already being done so admirably by the British Council and other bodies.

THE NATURE CONSERVANCY

AN article surveying the first two reports of the Nature Conservancy*, covering the work of the Conservancy for the period up to September 30, 1952, and for the year ended September 30, 1953, appears on p. 516 of this issue of *Nature*. Apart from their special scientific interest, they are of general interest as contributing to that wide understanding of the nature and importance of the work of the Conservancy which the Huxley Committee recognized as essential to the success of any system of nature reserves. Although the Nature Conservancy was constituted by Royal Charter "to provide scientific advice on the conservation and control of the natural flora and fauna of Great Britain; to establish, maintain and manage nature reserves in Great Britain, including the maintenance of physical features of scientific interest; and to organize and develop the scientific services related thereto", the management (and still more the designation) of nature reserves demands a large amount of local co-operation and support. Even on the scientific side, the Conservancy recognizes that the full achievement of some of its essential tasks, such as a continuing thorough biological survey of the British Isles, requires a good deal of co-operation

* The Nature Conservancy. Report of the Nature Conservancy for the period up to 30th September 1952. Pp. iii+83. 1s. 3d. net. Report of the Nature Conservancy for the year ended 30th September, 1953. Pp. iii+31. 1s. 3d. net. (London: H.M. Stationery Office, 1953.)

from individual naturalists and various specialized societies, and it is the Conservancy's duty to encourage and, where possible, extend this voluntary effort.

In the establishment of reserves in Great Britain, the Conservancy has obviously encountered some of the same difficulties as the National Parks Commission, and in its present judgment a considerable acceleration of the acquisition and declaration of new national nature reserves is essential in order to prevent the loss of sites of irreparable importance. This has proved a far more complex and difficult undertaking than was at one time supposed. Increasing pressure and mobility of population, and changing economic, technical and defence requirements are simultaneously reducing the available choice of surviving semi-natural habitats and are greatly increasing the difficulty of safeguarding them against competing claims, disturbance or deterioration. At September 30, 1952, nine nature reserves had been declared—two in Scotland and seven in England: a year later the total was only eleven, some of which represented parts only of the proposed eventual reserve areas, though the Kingley Vale and Ham Street reserves were substantially increased during the year. Negotiations over a number of other reserves had, however, led to agreement, although for some reason or other formal declaration during the year was not possible, and a much larger total of declarations during the coming year is anticipated. Special reference is made to Roudsea Wood, Westmorland, which, under a nature reserve agreement, will be used as a study and experimental area for the neighbouring Merlewood Research Station and to the Cairngorms. Approaches from the Scottish Committee of the Conservancy to landowners concerned regarding the establishment of a national nature reserve in the Cairngorms without prejudice to the climbing public and to the ultimate formation of a national park, in accordance with a resolution passed at a meeting in Inverness in January 1953, met with sympathetic response. By the end of September there was reasonable ground for hoping that any remaining points of difference might be cleared away and this group of mountains permanently safeguarded as a nature reserve.

The National Parks Act also empowers local authorities, in consultation with the Conservancy, to set up reserves, and although there are difficulties, particularly financial and in the provision of skilled biological management, the progress made indicates the existence of an encouraging amount of local understanding and support for the Conservancy's work. The first local authority to establish a nature reserve in its area was the Lincoln (Parts of Lindsey) County Council, which on August 1, 1952, made the requisite declaration of an area of some 300 acres of sand dune and salt marsh facing the Wash at Gibraltar Point. The East Lothian County Council has proceeded similarly with the declaration of Aberlady Bay, while in June 1953 a declaration by the Skegness Urban District Council in respect of that part of the Gibraltar Point range of dunes within its ownership and its boundaries brought the original area to 500 acres, all to be managed by the Lincolnshire Naturalists' Trust, Ltd. The Conservancy has also been consulted by the Cumberland County Council about the sand-dunes opposite Ravenglass, where there is an important gullery and ternery. Not only was great local interest shown in the complex relation between the bird colonies and the neighbouring human communities, but also all parties were agreed on the

importance of preserving the bird colony as an inheritance to be handed down to future generations.

During the past year, the National Trust has arranged for the Nature Conservancy to manage five properties of natural history interest. These are Llyn Idwal, on the Penrhyn estate; Blenheim Bog and North Fen, Esthwaite, in the Lake District; Soolt Head Island; and the Ruskin Reserve near Abingdon. There will be public access. The Conservancy has made temporary grants to the Royal Society for the Protection of Birds Reserve at Dungeness and to the Norfolk Naturalists' Trust Reserve at Hickling Broad for the employment of watchers or maintenance staff with the view of bringing back these reserves into first-class condition. While the most satisfactory division of responsibility and of labour between the various interested bodies has still to be worked out, the Conservancy has been much encouraged by the constructive and co-operative attitude which is so evident.

One reason for welcoming these reports and for giving them wide publicity is that they should help to remove the misunderstandings as to public access which have impeded negotiations, though probably to a lesser extent than in those leading to designation of national parks. Neither the designation of a park nor the declaration of a reserve confers any rights of public access, and the Act excludes declared nature reserves from its provisions for making access agreements in respect of what is defined in the Act as 'open country'. This does not mean that access to reserves will be generally denied. The Conservancy's policy is to allow as much access as is compatible with the proper scientific management of particular reserves. In those being used for experimental work, access must be carefully controlled; in some places access by permit, subject to compliance with stated conditions and to reasonable limitations of numbers, will be available to those generally interested. In other reserves the Conservancy hopes that the public will, by their behaviour, enable a policy of unrestricted access to be maintained.

A clear statement of the Conservancy's policy and the reasons governing the issue of permits to visit nature reserves which cannot be generally open to public access is appended to the report for the year ended September 30, 1953, and its wide circulation should both remove misunderstandings and encourage the local and general co-operation so helpful to the success of the Conservancy's work. Moreover, there is much material in these reports which demonstrates the importance of the scientific work of the Conservancy to the national economy. Now that its research stations at Merlewood, Morecambe Bay and at Furzebrook, Poole Harbour and its field stations (Ananoeum on Loch Maree and Moor House, Westmorland) are equipped and at work, and the initial reconnaissance and listing of sites of scientific importance is virtually finished in England (although much remains to be done in Scotland and Wales), it is to be hoped that the Conservancy will not be too pre-occupied with its research programme to neglect this important task of education and interpretation. Exposition at the appropriate moment of the significance of the results obtained in some of its scientific work, such as that on coastal erosion or the effects of spraying hedgerows and road-side verges with herbicides, or its studies on the ecology of the rabbit or of the introduction of reindeer in Scotland, could foster public understanding and goodwill, and thus help to ensure both that the modest sums required by

the Conservancy are provided by Parliament and that public access to the reserves causes neither abuse nor friction. It is satisfactory to note that in the latest report due stress is laid upon the development of the educational, information and intelligence aspects of the Conservancy's work and the preparation of suitable publications.

SICKNESS IN ENGLAND AND WALES

A RECENTLY published report from the Registrar General* describes three attempts to obtain statistics of morbidity, as distinct from mortality, in England and Wales. The study of mortality statistics was one of the main instruments of preventive medicine during the past hundred years. The statistics are extensive, detailed and complete. In their present form they represent the result of attempts to obtain information about human populations and not merely a by-product of administrative activity. By contrast, most existing statistics of morbidity are fragmentary and unsatisfactory, though they are of even greater potential interest than the mortality statistics. Most of the existing morbidity statistics, such as those derived from the records of Friendly Societies or hospitals, are incomplete in their coverage of the population; and most of them illustrate the limited value, for studies of general problems, of statistics originally collected for highly specialized purposes.

The three studies in the report under notice illustrate these general points, the first study being an account of the Survey of Sickness for the years 1948 and 1949. This Survey, using a designed sample, attempted to obtain information about sickness, duration of incapacity and frequency of medical consultation among the whole population. In principle, its results (here tabulated by age, sex and income of the persons interviewed) are of great importance in connexion with the operation of the National Health Service. In practice, the information obtained lacks precision, particularly as to the nature of the diseases causing incapacity. At best, the Survey provided information about what people thought was the matter with them. There is internal evidence, also, of the operation of memory effects. Nevertheless, the results of the Survey are interesting in themselves and will be even more interesting when they can be correlated with relevant statistics from other sources. Among these may be mentioned the results of an inquiry into hospital in-patient records conducted by the Registrar General, and the results of an analysis of claims to sickness benefit under the National Insurance Acts conducted by the Ministry of National Insurance. These results are apparently to be published in due course. In the meantime, it seems unfortunate that the Sickness Survey was abandoned in the interests of financial economy in 1952. Whatever the faults of this particular Survey may have been, investigations on similar lines offer the only means of obtaining morbidity statistics covering the whole population.

The second of the three studies illustrates another source of morbidity statistics, namely, records of admissions to hospital. The study is devoted to

statistics of mental disorders derived from the records of mental hospitals under the National Health Service. The results are interesting in themselves, but also serve to show the limitations of this source of information. The form designed for this inquiry proved too complicated to be satisfactorily completed by the hospitals. This is the converse of the usual situation in which the hospital administration produces records insufficiently detailed and standardized for the purposes of social medicine. The third study describes some of the results of the Cancer Registration Scheme relating to 1947 and 1948. Statistics for 1945 and 1946 have already been published elsewhere. This is an interim study describing an early phase of the construction of a complete statistical picture of this group of diseases. At present it covers only part of the population (that served by the hospitals taking part in the Scheme), but it achieves a high degree of diagnostic accuracy. It will in the end, no doubt, combine both accuracy and completeness. At present the tables give information about numbers of cases by age and sex and about the delay between first symptoms and starting of treatment for cancer of various sites.

EARTHQUAKES DURING 1953

THE five earthquakes which did most damage during 1953 occurred on February 12 (magnitude 7) in Persia; on March 18 (magnitude $7\frac{1}{2}$) in Turkey; during August a swarm (greatest on August 12, of magnitude $7\frac{1}{2}$) near Cephalonia; on September 10 (magnitude 6 $\frac{1}{2}$) near Cyprus; and on December 12 (magnitude $7\frac{1}{2}$) in Peru. In addition, nineteen other earthquakes were of magnitude 7 or more, the greatest being on November 25 (magnitude 8 $\frac{1}{2}$) near Japan.

Fourteen earthquakes had foci at depths of 200 km. or greater, the deepest occurring on April 14 (magnitude 7) in western Brazil and on November 4 off Korea, both having a depth of focus of 650 km.

The Persian earthquake in February occurred in the Province of Khorasan and devastated Shahrood, Torroud and neighbouring villages, killing hundreds of the inhabitants when their houses collapsed on them.

The Turkish earthquake of March 18 occurred south-east of the Dardanelles in the region of Chanak, Balıkesir, Yenice and Gonen, where more than a quarter of a million pounds sterling damage was done and hundreds of people were killed by falling debris and the fires which followed the earthquake.

The swarm of earthquakes in the Greek Ionian islands of Cephalonia, Ithaca and Zante culminated in the shock of magnitude $7\frac{1}{2}$ on August 12 and caused great damage, there being 394 deaths and a further 941 casualties (see *Nature*, August 22, p. 332). Argostoli, Lixouri and Zakynthos were particularly affected, and just after the earthquakes more than seventy-five thousand people were homeless. The International Seismological Association at Strasbourg reports that some 338 individual shocks occurred in the swarm of August 9-31.

The earthquake which did damage in the Paphos district of Cyprus on September 10 had a smaller magnitude than the others mentioned; but in the town of Ktima and the surrounding villages, including Stroumbi, Kithasi and Ayios Nikolaos, and even as

* The Registrar General's Statistical Review of England and Wales for the year 1949: Supplement on General Morbidity, Cancer and Mental Health. Pp. ix+186. (London: H.M.S.O., 1953.) 7s. 6d. net.

far as Limassol, much damage was caused; forty people were killed, a hundred injured, and just after the earthquake some four thousand were homeless.

From the reports from sixty-one observatories throughout the world, the epicentre of the earthquake of December 12 has been calculated by E. Peterschmitt and L. Behe at Strasbourg to be at lat. 3.7° S., long. 80.7° W., which is near the coast of Peru. Several people were killed as a result of this earthquake, and there was heavy property damage at Tumbes, Corrales and in the surrounding district.

Reports were received during the year directly from individual stations at Aberdeen, Arkansas, Belgrade, Cleveland (Ohio), Durham, Fayetteville, Karlsruhe, Kew, Lisbon, Lwiro (Belgian Congo), Pasadena, Perth (Western Australia), Toledo and Uccle; from collecting stations at De Bilt, Stuttgart, Wellington (New Zealand) and Zurich; and also from the International Seismological Association at Strasbourg and the United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association, where observations are collected and preliminary epicentres determined.

ERNST TILLOTSON

RADIO EVIDENCE OF THE EJECTION OF VERY FAST PARTICLES FROM THE SUN

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THE method of studying movements in the solar atmosphere by observing the spectrum of high-intensity radio noise from the sun has been discussed

in previous communications^{1,2}. It depends on the simple hypothesis that when the spectrum shows an abrupt low-frequency cut-off, the frequency of this cut-off can be identified with the critical escape-frequency at the source, and hence used for determining the height of the source in the solar atmosphere. The hypothesis has previously been applied to the outbursts of long duration for which the characteristic slow drift of the cut-off frequency can be explained in terms of disturbances which move outwards through the solar atmosphere at velocities¹ of the order of 500 km./sec. This result was confirmed in general terms by the directional observations of Payne-Scott and Little³. More recently, the critical-frequency hypothesis has been further substantiated by evidence that the observed cut-off must be attributed not to the natural profile of the emitted spectrum, but rather to severe attenuation of the lower frequencies in their escape from the sun⁴. This evidence was obtained by comparing profiles of the fundamental and the second harmonic (which is presumably unattenuated).

In the present communication we offer similar evidence for the application of the same hypothesis to another, more common, type of burst in which the frequency drift is much faster. Thence we infer the existence in the solar atmosphere of corpuscular ejections which move outwards at about one-fifth the velocity of light.

Type III Bursts

Using the previous nomenclature⁴, we shall refer to the two spectral classes mentioned above as type II (slow drift, duration 5–10 min.) and type III (fast drift, duration 5–10 sec.) respectively. In the course of observations between August 1952 and August 1953 with a wide-band (40–240 Mc/s.) spectroscopie, it was found that nearly all bursts, excluding those in noise storms, belonged to one of these two classes. In all, four outbursts of type II were recorded and several hundred bursts of type III. The latter

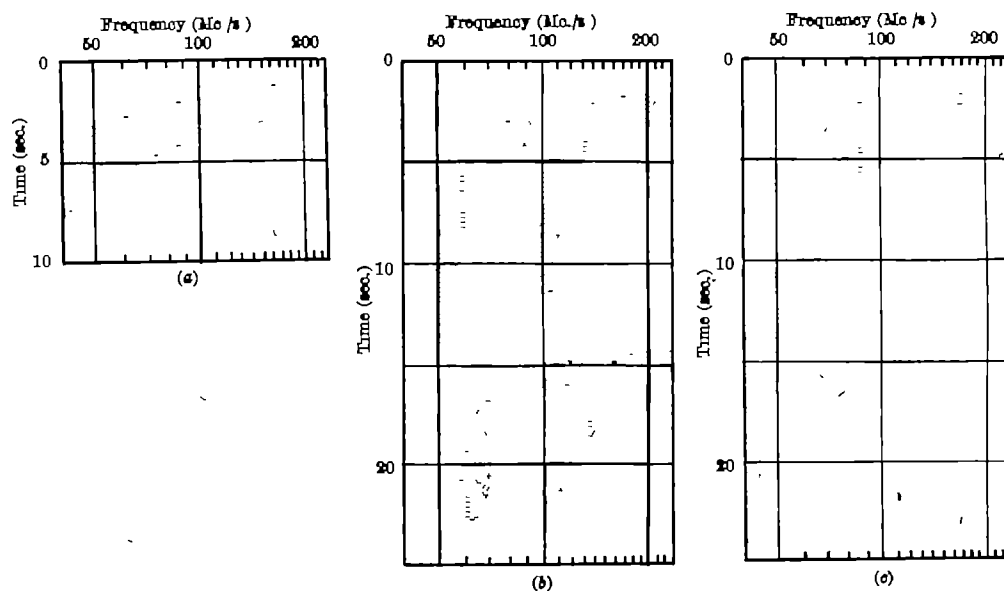


Fig. 1. Dynamic spectra of type III bursts. The shaded areas represent regions of high intensity in the frequency-time plane. (a) April 2, 1953, 0447 U.T. (b) Harmonic pair, Jan. 14, 1953, 0607 U.T. (c) Harmonic pair, June 6, 1953, 0136 U.T.

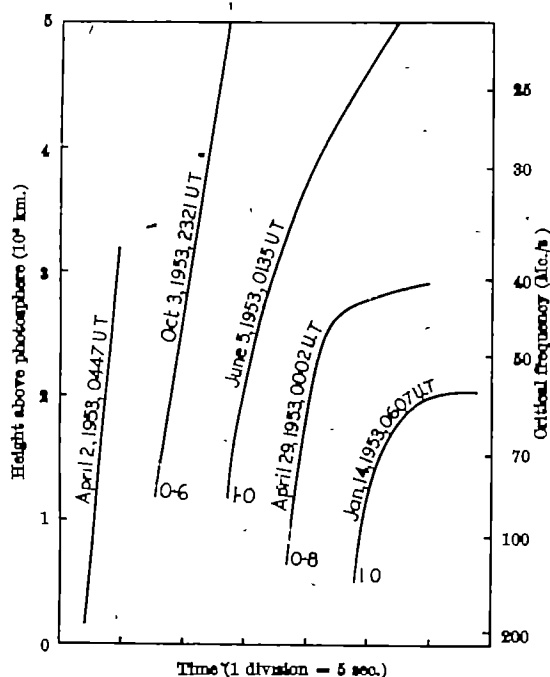


Fig. 2. Plot of derived motions in the solar atmosphere for a selection of type III bursts. The numbers on the curves give the approximate initial velocity in units of 10^4 km./sec. The first, third and fifth correspond to Figs. 1 a, c and d, respectively.

occurred sometimes in isolation but more commonly in small groups. On a few occasions we observed an intense compact cluster of type III bursts producing high-level radiation almost continuously for a period of 1-2 min. We have evidence that such clusters sometimes occur at the time of solar flares.

The dynamic spectrum of a simple type III burst, of the kind described previously¹, is shown in Fig. 1 a. The spectrum extends over the entire range, the rate of frequency-drift decreasing steadily with time. But the greater frequency-range of the present apparatus has revealed new features in type III spectra. First, the rate of drift is often observed to decrease so rapidly at the lower frequencies that the emitted peak becomes almost 'stopped' at a fixed frequency (see Fig. 1 b). Secondly, it is common to find bursts occurring in harmonic pairs, in which spectral features of a burst are duplicated at double the frequency (see Figs. 1 b and c). Just as in the case of type II bursts, comparison of the profiles of fundamental and second harmonic normally indicates that the low-frequency skirt of the fundamental has been cut off during escape. It is this result that justifies the application of the critical-frequency hypothesis to type III bursts.

Two explanations based on this hypothesis have been suggested to account for the systematic frequency-drift of type III bursts². In one, the drift is attributed to the motion of a disturbance which travels out-

ward through the solar atmosphere, thus passing through regions of steadily diminishing electron density. In the other, it is attributed to the rapid dispersion of a stationary, dense cloud situated in the outer corona. The latter interpretation now seems untenable because, with any reasonable distribution of electron-density in the cloud, the predicted band-width would be much broader than that observed in many of the bursts (for example, Fig. 1 c). In what follows we adopt the former interpretation and show that it accounts naturally for the known properties of the bursts. On current evidence the case in favour of this interpretation seems strong in view of the very reasonable physical picture which it yields and the simplicity with which it explains the more complicated disturbances ('compound bursts') discussed below.

The derived movements associated with a representative selection of type III bursts are shown in Fig. 2 as a plot of coronal height against time. In this diagram the critical-frequency levels have been calculated from the Allen-Baumbach model and the observed range of levels has been extended by using second harmonics. The initial velocities lie in the range 3×10^4 – 10^5 km./sec. (0.1 c.–0.3 c.). Although in some cases the velocity remains almost constant throughout the observed range of heights, none has yet been found with outward acceleration. However, deceleration is common, and in cases such as Fig. 1 b (corresponding to the last curve of Fig. 2), the disturbance is apparently brought to rest at some height within the observed range. In some bursts there is evidence of considerable spread in velocity, whereas in others the narrow band-width means that the spread could be no greater than about 20 per cent of the mean velocity.

The moving disturbances may be explained as corpuscular streams, since at such high velocities protons and electrons would pass through the corona almost unimpeded by collisions. We may note that the emission of very fast particles at the time of solar flares is consistent with a known terrestrial phenomenon. At a velocity of 5×10^4 km./sec., particles reaching the earth would do so 50 min. after the onset of the flare. This is typical of delays observed between solar flares and the increases in cosmic-ray intensity that occasionally accompany

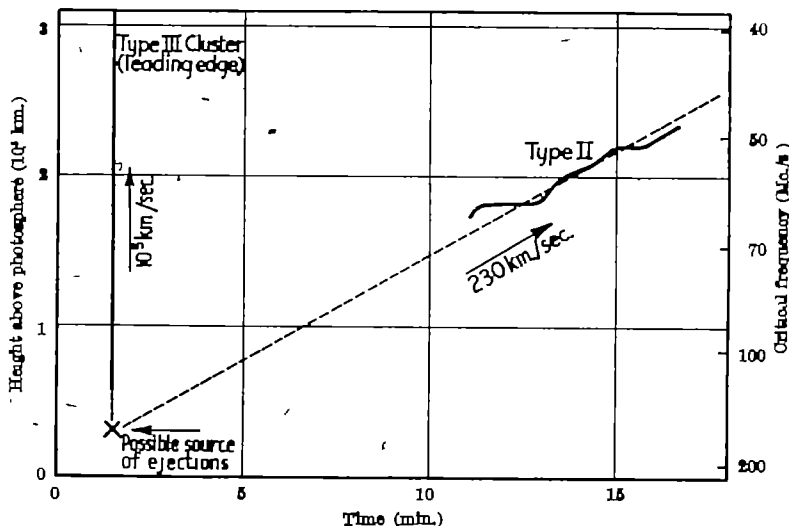


Fig. 3. Plot of the derived motions in the solar atmosphere for a compound burst (Sept. 1, 1953, 0836 U.T.).

them⁶. It is possible, therefore, that type III bursts are caused by cosmic rays of solar origin. However, it should be remarked that unless the particles are much heavier than protons, their energies at velocities of the order of 5×10^4 km./sec. must be considerably lower than those deduced by cosmic-ray investigators. Nevertheless, the 'low' velocities seem to offer the only simple explanation of the long time delays.

Compound Bursts

We now know that two kinds of activity may occur at the time of solar flares: the type II outbursts and the type III clusters. During the year, we have recorded four of the former and ten of the latter. Either kind may occur without the other, but on three occasions we have observed the combination of the two. On each occasion the type II burst followed the type III cluster after a time delay of several minutes.

An example is shown in Fig. 3, plotted in terms of heights in the solar atmosphere. The calculated velocities are 230 km./sec. for the type II burst and 1.0×10^5 km./sec. for the type III. Both the velocity and the time delay of the type II differ considerably for the three cases observed. Yet in each case extension of the velocity lines towards the origin yields a point of intersection in the lower corona within 10^4 km. of the photosphere. This suggests that the two portions of the compound burst are associated with disturbances, perhaps streams of matter, ejected simultaneously from a common source located low in the solar atmosphere. Such an 'explosion' may well be the primary cause of the flare.

Speculation on the physical nature of this phenomenon has led us to consider several possible mechanisms.

(1) An explosion involving thermo-nuclear or chain reactions between nuclei of light elements, the products being emitted with characteristic velocities. Such explosions do not seem feasible at the low densities believed to exist in the solar atmosphere, but it is not known whether they may occur slightly below the photosphere.

(2) A sudden accelerating process involving large-scale electric and magnetic fields. The two velocities could result from the acceleration of charged particles of very different mass in the same field. However, the large velocity ratio may be difficult to explain.

(3) A disturbance of some kind which gives rise to the combination of a fast corpuscular ejection and a shock wave. It is noteworthy that the typical slow (type II) velocity is of the order of the mean speed of thermal protons in the corona, which may be identified with the velocity of sound.

We wish to thank Mr. W. C. Rowe and Mr. J. Joise for assistance in the observational phase of this work, and also Prof. E. E. Salpeter for a valuable discussion on nuclear reactions in the sun.

[Dec. 14.

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SOME PHYSICAL PROPERTIES OF METALLIC PLUTONIUM

FOLLOWING a recent declassification decision, it is now permissible to disclose some of the properties of metallic plutonium (Pu, $Z = 94$).

Between room temperature and its melting point, pure plutonium was found to exist in five allotropic modifications, labelled α , β , γ , δ , ϵ . The temperatures at which the phase changes occur are given in Table 1, determined by dilatometry at heating- and cooling-rates of about $1\frac{1}{2}$ deg. C. per min.

Table 1. TRANSITION TEMPERATURES ($^{\circ}\text{C}$.)

	Heating	Cooling
$\alpha \rightarrow \beta$	126	85
$\beta \rightarrow \gamma$	235	About 160
$\gamma \rightarrow \delta$	280	250
$\delta \rightarrow \epsilon$	480	480

During cooling, the $\epsilon \rightarrow \delta$ change occurs with little or no temperature hysteresis; but the remaining transformations show considerable sluggishness, which makes it difficult to quote temperatures for the start of the $\delta \rightarrow \gamma$ and $\gamma \rightarrow \beta$ changes. The $\beta \rightarrow \alpha$ transformation commences sharply at 85°C ., and continues slowly at room temperature.

The density of α -plutonium at room temperature has been determined by the measurement and weighing of pressed geometrical shapes, and by displacement. The approximate densities of the other phases have been found from dilatometer measurements. Typical figures are given in Table 2: the values for the β , γ , δ and ϵ phases refer to the low-temperature end of the stable range of the phase.

Table 2. DENSITIES OF PHASES OF PLUTONIUM (gm./c.c.)

α	β	γ	δ	ϵ
19.0	17.4	16.0	15.4	16.4

Features of interest in this table are the considerable increase in density on passing from the δ - to the ϵ -phase, and the large difference in density between the densest (α) and the least dense (δ) phase.

Table 3 gives values for the coefficients of thermal expansion of the various phases. In the α -, β - and δ -phases the coefficients vary considerably with the temperature, but in the γ - and ϵ -phases the expansions are almost linear. The values given are taken at the middle of the appropriate temperature-range.

Table 3. COEFFICIENTS OF LINEAR THERMAL EXPANSION (parts in $10^6/^{\circ}\text{C}$.)

α	β	γ	δ	ϵ
(below 70°C .)	(above 70°C .)	(below 190°C .)	(above 190°C .)	
40	66	32	54	48 -33 20

A most interesting feature is the negative temperature coefficient of expansion shown by δ -plutonium. This behaviour is perhaps unique in a polycrystalline pure metal. At the low-temperature end of the stability range of the δ -phase, the coefficient of expansion is very small and becomes negative at high temperatures, getting numerically greater as the temperature increases to the $\delta \rightarrow \epsilon$ change point at 480°C .

The work described above was directed by Mr. G. L. Hopkin, to whom I am indebted for encouragement and advice. I also acknowledge help from

numerous colleagues, particularly Messrs. R. G. Hambling, A. Knight and R. Willows of this Establishment. My thanks are due to Sir William Penney, director of this Establishment, for permission to publish this communication, and to Sir John Cockcroft, director of the Atomic Energy Research Establishment, for facilities.

W. B. H. LORD

Atomic Weapons Research Establishment,
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Feb. 5.

CONCURRENTLY with the above work, a more extensive programme of research was carried out at the Atomic Energy Research Establishment, Harwell. The transition temperatures between the five allotropic modifications of plutonium have been determined by several methods, the results being summarized in Table 4. The temperatures quoted are approximate typical values, given to the nearest multiple of five degrees; extensive experiments show considerable variations from specimen to specimen. In most cases actual experimental values are within a range of $\pm 5^\circ \text{C}$; but isolated results have been obtained well outside this range.

The electrical resistance and the coefficients of electrical resistance and thermal expansion on heating are given in Table 5. Behaviour on cooling is complicated by severe hysteresis effects and sluggish transformations, so that to quote simple values without extensive qualification would be misleading. Values for cooling are therefore omitted.

The density of α -plutonium has been determined by the displacement method, and values for the other phases have been calculated from the dilatation curves on heating. Variations in the density have been observed from specimen to specimen. The value quoted is for a specimen after standing for several months at room temperature. A typical value for specimens immediately after dilatation runs is about 18.7 gm./c.c., the low figure being presumably due to the retention of other phases. The values given for the β -, γ -, δ -, ϵ -phases are typical for these phases at the lower end of their stable range (Table 6).

Table 6

Phase	Density (gm./c.c.)
α	19.25
β	17.3
γ	16.7
δ	15.7
ϵ	16.8

Full discussion of the theoretical implications will become possible only when security limitations permit the disclosure of some other properties of plutonium; but in addition to the negative coefficient of thermal expansion of the δ -phase, and the large density difference between the latter and the α -phase, the following points may be noted:

(a) The relatively high values of electrical resistivity and the negative and extremely low temperature coefficients of resistance of some of the phases.

(b) The large hysteresis associated with the $\delta \rightarrow \gamma$, $\gamma \rightarrow \beta$ and $\beta \rightarrow \alpha$ phase-changes, and the complete absence of hysteresis in the onset of the δ -phase change which, however, proceeds only partly to completion, even with long soaking periods.

(c) The large variations in properties between one specimen and another, which it is difficult to account

Table 4

Phase	Transition temperatures ($^\circ\text{C}$)					
	Thermal analysis*		Dilatometry†		Electrical resistance*	
	Heating	Cooling	Heating	Cooling	Heating	Cooling
$\alpha \rightleftharpoons \beta$	140	90	125	80‡	125	90‡
$\beta \rightleftharpoons \gamma$	235	145‡	235	Transformation obscured on all specimens due to sluggishness	230	160‡
$\gamma \rightleftharpoons \delta$	325	345‡	315		325	325‡
$\delta \rightleftharpoons \epsilon$	475	475	490		490	490‡
Melting and freezing points	640	640		480‡		

* Rates of heating and cooling, approximately 2 deg. C. per min.

† Rates of heating and cooling, approximately 1 deg. C. per min.

‡ Ill-defined transitions on some specimens; arrests obscured on others.

§ Start of transition; transformation occurs progressively to room temperatures, and sometimes continues isothermally.

|| On cooling, the change does not appear to go to completion; the density decreases only from 16.3 to about 16.1.

Table 5

Phase	Resistivity* (microhm cm.)	Coefficient of electrical resistance on heating per deg. C. ($\times 10^{-4}$)	Linear coefficient of thermal expansion on heating per deg. C. ($\times 10^{-5}$)
α	150	-20 to -40‡	+50 to 65‡
β	116	-10	+43
γ	115	-4 to -20‡	+39
δ	111	+7	+27‡
ϵ	123	—	+20‡

* Mean figures for several specimens; they refer to the low-temperature end of each range. The variation from specimen to specimen is about ± 3 microhm cm. The values for β -, γ -, δ - and ϵ - have been corrected for volume changes on the basis of isotropic expansions from the α -phase.

† The curve is not linear; these are limiting values for several specimens.

‡ These are limits for several specimens; one specimen gave a value of $+20 \times 10^{-5}$.

§ The curve is not linear over the whole range; this is a typical value for the linear portion of the curve.

|| Typical values for several specimens; variations from approximately 5 to 30×10^{-5} have been observed on some specimens.

for by the presence of impurities if normal experience is taken as a basis for comparison.

Many features of the behaviour of plutonium have been necessarily omitted from this short summary; but it is hoped to publish a more detailed account of the experimental results elsewhere.

We wish to thank Dr. H. M. Finnieston and Dr. M. B. Waldron for helpful criticism and discussion during the work, and Sir John Cockcroft, director of the Atomic Energy Research Establishment, for permission to publish this communication.

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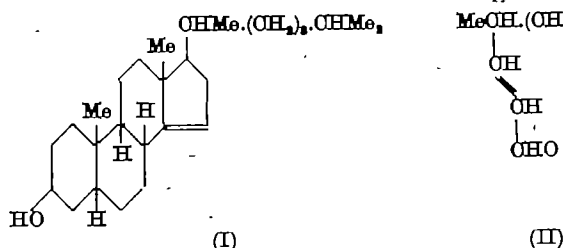
Atomic Energy Research Establishment,
Harwell, Berkshire. Feb. 5.

LETTERS TO THE EDITORS

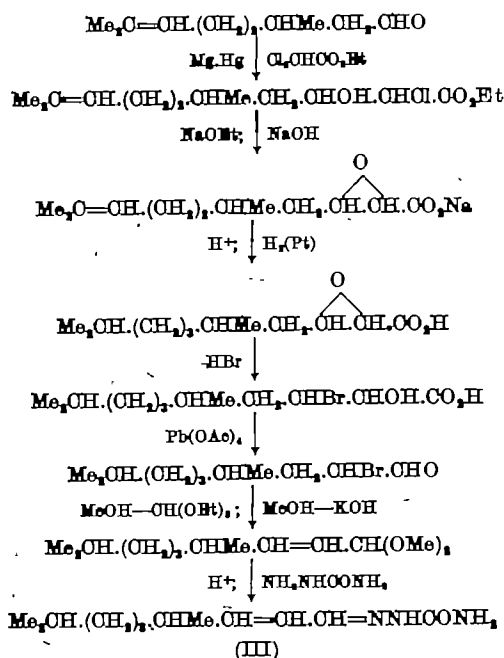
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Absolute Configuration of Cholesterol

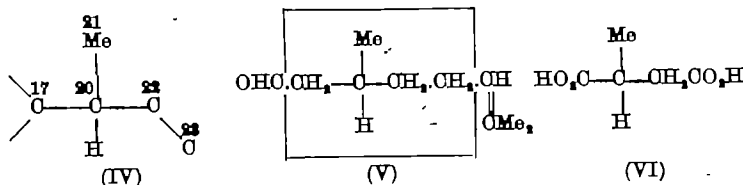
In the course of more extensive work on degradation of cholesterol, we have made a stereochemical correlation which seems to justify an interim report.



Ozonolysis of cholest-14-en-3 β -ol (I) and pyrolysis¹ of the product at 210–220° in cyclohexane gave, as one fragment, an $\alpha\beta$ -unsaturated aldehyde (II) which formed a crystalline, levorotatory semicarbazone (III) from (+)-citronellal by the following process:



The semicarbazone from cholesterol had a melting point of 133° (somewhat variable owing to polymorphism), $[\alpha]_D^{25} - 24.5^\circ$ ($c = 1$, dioxan). The semi-



carbazone from citronellal had a melting point of 133°–135°, $[\alpha]_D^{25} - 22^\circ$ ($c = 1$, dioxan). There was no depression of melting point on admixture. The infra-red spectra (in potassium bromide) were identical. X-ray diffraction photographs of single crystals confirmed the essential identity of the two specimens, though there was a difference in gross crystalline habit, possibly due to slight racemization of one specimen. We are obliged to Mrs. O. Kennard for this comparison and to Dr. R. K. Callow for the infra-red spectra.

The aldehyde (II) contains C_{14} of cholesterol as the sole asymmetric centre, and the spatial relationship of C_{14} with the other asymmetric centres of cholesterol is known, mainly from the crystallographic analysis of cholesteryl iodide². Briefly, if the absolute configuration of the ring system in steroids is represented correctly by the conventional projection (as in (I), for example), then the absolute configuration about C_{14} is represented by (IV)³.

On the other hand, (+)-citronellal (V) has been degraded to (+)-methyl-succinic acid in the sense indicated by the dotted lines⁴. The latter acid, according to Fredga's evidence⁵ obtained from a study of 'quasi-racemates', belongs to the D-glycer-aldehyde stereochemical family and has the configuration (VI). If this assignment is accepted, it follows that the assignments (V) and (IV) are also true and that the conventional projection of the steroid molecule really represents the absolute configuration. This confirms the conclusions drawn by Mills⁶ from optical rotation differences and by Prelog⁷ from the stereochemical course of asymmetric syntheses.

A detailed account of this work will be published elsewhere.

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¹ Cf. Aochermann, T., *J. physiol. Chem.*, **235**, 141 (1934). Laught, F., *J. physiol. Chem.*, **237**, 236 (1935), for analogous work with cholesterol.

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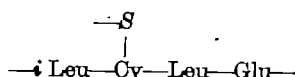
Structure of Bacitracin A

In a recent letter, Porath¹ reported that bacitracin A with an activity of 60 units/mgm. could be obtained by chromatography on charcoal. From an analysis of the peptides formed by hydrolysing this material with 6 N hydrochloric acid for 72 hr. at 37°, he tentatively suggested a partial structure for the molecule.

We have studied the products of hydrolysis of a sample of commercial bacitracin (Commercial Solvents Cor-

poration, Lot 311, 47 international units/mgm.), and of a sample of bacitracin A hydrochloride (72 international units/mgm., corresponding to 77 units/mgm. for the free base) prepared by a short counter-current distribution in the system described by Newton and Abraham³. So far as our analysis has proceeded, the two samples have given similar results. The samples were hydrolysed with 11 N hydrochloric acid at 37° for periods varying from one to six days, and in some experiments the latent thiol group^{3,4} was oxidized to SO₂H with performic acid⁵. Electrophoresis and chromatography on paper were used to separate and characterize the resulting peptides, and 1:2:4-fluorodinitrobenzene⁶ to determine their N-terminal amino-acids. Although a number of these peptides conform to portions of the amino-acid sequence postulated by Porath¹, others appear to have structures which are inconsistent with this sequence as a whole.

After hydrolysis for six days, significant amounts of free histidine, ornithine, aspartic acid and glutamic acid were found. Among the dipeptides which appeared to be present were leucylglutamic acid, β -sulphoalanylleucine and isoleucylcysteine acid. Other products included a tripeptide of cysteine acid, leucine and glutamic acid (with cysteine acid as the N-terminal amino-acid) and a tetrapeptide of isoleucine, cysteine acid, leucine and glutamic acid (which appeared to have isoleucine as the N-terminal amino-acid). These results would require the following sequence to be present in bacitracin A:



Further results suggest that the left-hand side of this sequence can be extended through a peptide containing ornithine, phenylalanine and isoleucine residues (with ornithine as the N-terminal amino-acid), and that the glutamic acid on the right-hand side is close to aspartic acid. Since the molecule appears to contain a cyclic chain^{3,4}, this arrangement, like the structure suggested by Porath¹, implies that most of the polar side-chains are grouped together on one part of the ring and most of the non-polar side-chains on the other.

There is general agreement that the δ -amino group of the ornithine residue and the imidazole group of the histidine residue in bacitracin A react with 1:2:4-fluorodinitrobenzene, but that the ϵ -amino group of the lysine residue is masked^{1,3,4}. In addition to the basic groups provided by the ornithine and histidine residues, bacitracin A contains a third basic group, which titrates in the region of a peptide α -amino group³. Craig, Hausmann and Weisiger⁴ have stated that bacitracin A behaves as though it contains two free amino groups in the Van Slyke determination of amino-nitrogen. Newton and Abraham³ reported that, after reaction with 1:2:4-fluorodinitrobenzene, bacitracin A yielded dinitrophenyl-leucine or -isoleucine on hydrolysis; but Porath¹ was unable to repeat this observation, and Ingram⁷ could demonstrate no N-terminal amino-acid by reductive methylation. We have now confirmed that hydrolysis of our sample of dinitrophenyl-bacitracin A yields an ether-soluble dinitrophenyl-derivative which runs on paper chromatograms⁸ like dinitrophenyl-isoleucine and yields a substance which behaves like isoleucine on hydrolysis with baryta⁹. The dinitrophenyl-deriva-

tive of commercial bacitracin (which contains some bacitracin B) yields, in addition, a substance which behaves like dinitrophenyl-valine. However, the yield of dinitrophenyl-isoleucine (and dinitrophenyl-valine), while too large to be neglected, is considerably less than the yield expected from one N-terminal group per molecule. Moreover, an attempt to degrade bacitracin by the method of Edman¹⁰, using the procedure of Landmann, Drake and Dillaha¹¹ to characterize the products on paper chromatograms, yielded only about 5 per cent of the theoretical amount of 3-phenyl-2-thiohydantoin expected from an N-terminal isoleucine. It therefore remains uncertain, from these experiments, whether the third basic group of bacitracin A is responsible for the formation of dinitrophenyl-isoleucine, or whether this group is part of some hitherto uncharacterized structure in the molecule.

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Jan. 14.

¹ Porath, J., *Nature*, **178**, 871 (1953).

² Newton, G. G. F., and Abraham, E. P., *Biochem. J.*, **47**, 257 (1953).

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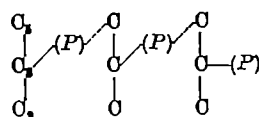
¹¹ Landmann, W. A., Drake, M. P., and Dillaha, J., *J. Amer. Chem. Soc.*, **78**, 3638 (1953).

Evidence for the Existence of Two Types of Ribonucleic Acid

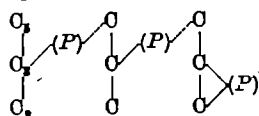
THE predominant internucleotide link in ribonucleic acids is now known to be a phosphodiester link between the 3' position of one nucleoside residue and the 5' position of the neighbouring residue, regardless of whether the nucleoside residue contains a purine or a pyrimidine¹. Assuming for the moment that all the nucleic acid chains have equivalent numbers of base and phosphate residues, the chains may be built up in one of two ways. These are represented diagrammatically in formulae I (a and b) and II, where O₁, O₂, and O₃ represent positions 2', 3' and 5' of the nucleoside residues, (P) a phosphate group; in each case the two terminal and one internal nucleoside residues are depicted.

A ribonucleic acid of type I may be considered as being built up of nucleoside 3' phosphates, whereas type II is built up of nucleoside 5' phosphates. For convenience, we shall call those end residues which bear only a phosphate group joining them to the remainder of the chain terminal 'nucleoside residues', and those which bear an additional phosphate group, terminal 'nucleoside 5'', or '3'', or 2':3' cyclic phosphate residues', depending upon the position occupied by the phosphate group.

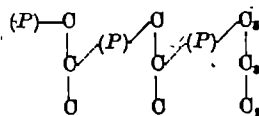
In the ribonucleic acids from yeast and turnip yellow mosaic virus, Markham and Smith² showed the presence of two main types of end groups, namely, terminal purine or pyrimidine nucleoside 3'



(Ia)



(Ib)



(II)

(or 2') phosphates and purine nucleoside 2':3' cyclic phosphates. The other ends of the chains were assumed to be occupied by nucleoside residues; thus the nucleic acids were taken to be of types Ia and Ib.

We now have evidence that, in the case of the ribonucleic acids from tobacco mosaic virus and potato virus X, a substantial proportion of the chains are of type II. From Brown and Todd's theory of the acid and alkaline degradation of ribonucleic acid⁸, a chain of type I will yield only nucleoside 2' and 3' phosphates on alkaline hydrolysis, whereas that of type II will, in addition, give nucleosides from the terminal nucleoside residues, and a mixture of nucleoside 2':5' and nucleoside 3':5' diphosphates from the terminal nucleoside 5' phosphate residues. Tobacco mosaic virus nucleic acid was prepared by heating purified virus to 93°C. for 3 min. in neutral solution in the presence of salt. The denatured protein was centrifuged off and the nucleic acid precipitated by the addition of two volumes of ethanol. When an alkaline hydrolysate (*N* potassium hydroxide at 20° for 18 hr.) of tobacco mosaic virus nucleic acid is run on paper electrophoresis in borate buffer at pH 9, in addition to the single band of mononucleotides, two other ultra-violet absorbing bands are observed. One band moving faster than the mononucleotides has the expected mobility of the nucleoside diphosphates. The other migrates more slowly than the mononucleotides, in the position of the ribonucleoside borate complexes.

The nucleoside diphosphates migrate in the expected positions on paper electrophoresis at pH 7.4 and pH 9 (when they bear four negative charges due to the primary and secondary dissociations of the two phosphate groups) and on paper chromatography in isopropanol-water-ammonia⁹. On paper electrophoresis at pH 3.5 they separate into three bands corresponding to (a) an unresolved mixture of cytidine and adenosine diphosphates, (b) guanosine diphosphate and (c) uridine diphosphate. On hydrolysis in *N* hydrochloric acid for 1 hr. at 100° and paper chromatography in isopropanol-hydrochloric acid⁹, the purine nucleoside diphosphates yield adenine and guanine while the pyrimidine nucleoside diphosphates are unchanged and move in the positions of cytidylic and uridylic acids. By these means we have isolated

substances with the expected ultra-violet absorption spectra of the diphosphates of adenosine, guanosine and uridine, and which were found to have molar ratios of base to phosphorus of approximately 1:2.

The nucleoside band isolated by electrophoresis at pH 9 contains ribose but no phosphorus, and on paper chromatography in *n*-butanol-water-formic acid⁹ separates into bands moving in the positions of the nucleosides. Adenosine, which occurs in the greatest amount, has been identified by its ultra-violet absorption spectrum.

By hydrolysis with *N* hydrochloric acid and chromatography in isopropanol-hydrochloric acid the relative proportions of the four nucleosides and the four nucleoside diphosphates have been measured. These were very different from the proportions of the four nucleotides in the entire nucleic acid. The relative proportions of adenosine among the nucleosides and of uridine diphosphate among the nucleoside diphosphates are considerably higher than those of adenylic and uridylic acids respectively in the whole nucleic acid.

The intact nucleic acid was treated with purified prostate phosphomonoesterase at pH 5.3 for 18 hr. at 37°, precipitated with two volumes of ethanol and hydrolysed with alkali. Virtually no nucleoside diphosphates were then found, although the nucleosides had increased relatively in amount. This demonstrated that the diphosphates did in fact originate from terminal residues bearing singly esterified phosphate groups. From the increase in nucleosides, it appears that terminal nucleoside 2' or 3' phosphate groups were also present⁸.

In tobacco mosaic virus nucleic acid, about one residue in fifty yields a nucleoside diphosphate on alkaline hydrolysis, while the proportion of nucleoside end-groups is somewhat higher. This would suggest that the size of tobacco mosaic virus ribonucleic acid is of the same order as that of the turnip yellow mosaic virus¹⁰ and is considerably smaller than has been deduced from physical measurements¹¹. While alkaline hydrolysates of potato virus X ribonucleic acid contain similar amounts of nucleosides and nucleoside diphosphates, these substances were not detected in the ribonucleic acid of turnip yellow mosaic virus, thus confirming that the latter is of type I. They appear to be present in small amounts in ribonucleic acids from *Bacterium coli* and mouse liver.

It has been shown that the terminal nucleoside 5' phosphate residues did not originate during the preparation of the tobacco mosaic virus nucleic acid in the following ways: (1) intact tobacco mosaic virus hydrolysed with alkali gives nucleoside diphosphates; (2) heating turnip yellow mosaic virus nucleic acid, in the way used during the preparation of tobacco mosaic virus nucleic acid, does not lead to the appearance of nucleoside diphosphates in alkaline hydrolysates, and (3) the proportions of nucleosides and nucleoside diphosphates in alkaline hydrolysates of tobacco mosaic virus nucleic acid are not changed by varying the method of preparation of the nucleic acid, or by pretreatment of the virus by grinding or with ultrasonic radiation.

We conclude that, in tobacco mosaic virus and potato virus X ribonucleic acids, a large proportion of the chains are of type II. In addition, some of the chains are of type I, while the non-equivalence of nucleosides and diphosphates in alkaline hydrolysates shows that chains with other combinations of the four possible types of end groups must exist.

Examination of the distribution of these different types of end groups in nucleic acids from related strains of the viruses may show differences not apparent in the gross composition of the nucleic acids.

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Detection of Free Hydroxyl Radicals during the Oxidation of Cellulose in Air

It is well known that when dyed cellulose fabrics are printed with pastes containing the reducing agent sodium sulphonylate formaldehyde, and steamed, in order to produce a white design on a coloured ground, the white parts of the pattern are sometimes weakened^{1,2}. The weakness is due to oxidation of the cellulose at the printed places, and it has been shown that the oxidation occurs only when the fabric is left in humid conditions for some hours after the steaming operation and before the residual printing paste is washed off. During this period the unused reducing agent undergoes oxidation by atmospheric oxygen, and this reaction is accompanied by one in which the cellulose is oxidized. The simultaneous oxidation of sodium sulphonylate formaldehyde and cellulose, in the absence of the printing adhesives, has recently been investigated in these laboratories. In some of these experiments cellulose fabric was impregnated with a solution of neutral sodium sulphonylate formaldehyde to which naphthalene-1-sodium sulphonate had been added. The impregnated fabric, after storage in a moist atmosphere for several hours, was made alkaline and treated with an excess of diazotized sulphanilic acid, whereupon a pink colour developed. This pink colour can only have arisen by the coupling of the diazonium compound with a naphthol derived from the naphthalene sulphonate, and it is difficult to conceive any way in which hydroxyl groups can have been introduced into the naphthalene sulphonate except as free hydroxyl radicals (cf. Weiss and Stein^{3,4}). No evidence, either of the oxidation of cellulose or of the presence of free radicals, has been obtained when sodium bisulphite, sodium bisulphite formaldehyde, or alkaline sodium sulphonylate formaldehyde are oxidized on cellulose in this manner. Neutral sodium sulphonylate formaldehyde is also oxidized quite readily on glass fabric, but without formation of hydroxyl radicals.

It appears, therefore, that free radicals are involved in the oxidation of cellulose under the conditions used in these experiments, and that the radicals can only be detected when both the sodium sulphonylate

formaldehyde and the cellulose are undergoing oxidation simultaneously.

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Electrophoretic Separation on Filter Paper of the Soluble Liver-Cell Proteins of the Rat using Borate Buffer

THE electrophoretic analysis by the ordinary Tiselius apparatus of the soluble proteins isolated from rat liver has already been described¹⁻³; but the constituent components reported by these authors differed one from the other.

In order to find a convenient method with consistent results, an electrophoretic separation on filter paper of the soluble proteins of liver cells of the rat was attempted in a way similar to the well-known method for serum proteins. This communication deals with such a separation of the soluble proteins obtained by homogenization and differential centrifugation from livers of healthy rats.

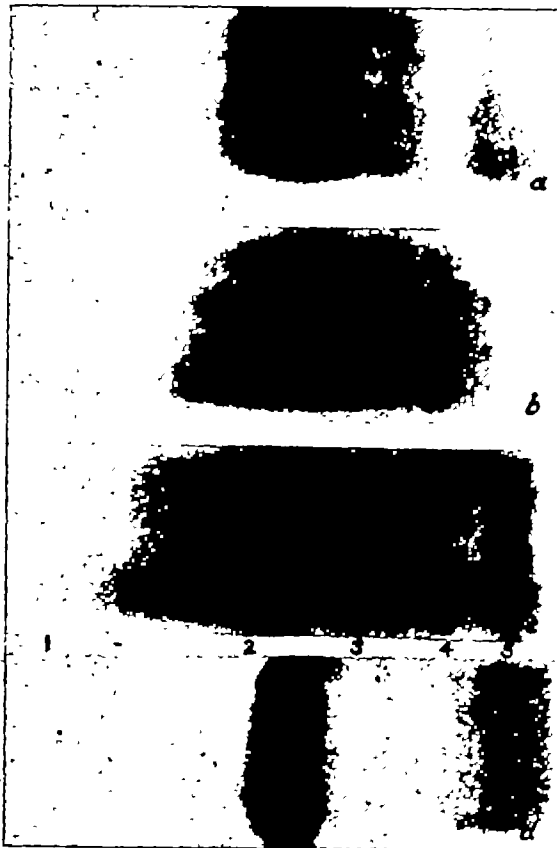


Fig. 1. Electrophoretic separations on filter paper of the soluble liver cytoplasmic proteins of the rat. The strips were stained using naphthalene black. (a) Veronal buffer pH 8.6, μ 0.1. (b) Phosphate buffer pH 8.0, μ 0.1. (c) Borate buffer pH 8.6, μ 0.18. The five bands are numbered from 1 to 5 in order of mobility. (d) Material used 48 hr. after preparation (borate buffer).

The following technique has been used for overcoming some difficulties and stabilizing a reproducible method.

A combination of a freeze-drying process and homogenization in isotonic sucrose solution permits a concentration of proteins suitable for paper electrophoresis to be obtained without denaturation of the proteins. The livers removed from the exsanguinated animals were frozen within 15 min. after death and dried *in vacuo*. The gently powdered dried material was suspended in isotonic sucrose solution containing 0.2 per cent of versene, and homogenized with a Potter-Elvehjem glass homogenizer. The isolation of cellular fractions was then carried out by differential centrifugation⁴. The final supernatant containing the soluble cytoplasmic proteins was clear and transparent with pH 6.8 and a protein concentration, depending upon the initial dilution, of about 4 per cent.

Immediately after preparation, 0.02 ml. of this solution was allowed to run overnight on strips of Whatman No. 1 filter paper in an electrophoretic apparatus similar to that described for serum proteins⁵ (potential gradient 15 V. per cm.).

A series of experiments was carried out to find a suitable buffer solution which would differentiate the velocity of migration of the various protein fractions. The only suitable solution was found to be a borate buffer of pH 8.6 and $\mu = 0.18$.

A clear resolution of five major protein components was obtained and developed by staining the strips with naphthalene black (Fig. 1c). Figs. 1a and b show the less satisfactory separations with a veronal and a phosphate buffer of pH 8.6 and $\mu = 0.1$.

An important point on which the success of the separation depends is the freshness of the prepared material. The ageing of the protein solutions was investigated and it was found that a noticeable alteration occurs within twenty-four hours, and within forty-eight hours the proteins migrate as a single band with no separation (Fig. 1d).

I wish to thank Dr. D. J. R. Laurence for helpful advice.

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A Crystalline Chlorophyll-Protein Complex from *Chlamydomonas*

THE isolation of a crystalline chlorophyll-protein complex from clover was recently reported and illustrated by Takashima¹. Spikes, Lumry and Anderson² repeated the crystallization of this complex from thirty species of plants. We have also obtained material with a very similar appearance from many green leaves; for example, clover, *Trifolium repens*; cocksfoot, *Dactylis glomerata*; bracken fronds, *Pteridium aquilinum*. In addition, an apparently crystalline chlorophyll-protein complex has been obtained from a species of alga, *Chlamydomonas*.

Chlamydomonas dorsoventralis (Culture Collection of Algae, Cambridge) was grown in an inorganic salt medium³ aerated with 5 per cent carbon dioxide - air under artificial illumination. The cells were harvested, suspended in a small volume of medium and an equal volume of α -picoline added. The suspension was then centrifuged and dioxan added to the clear green supernatant to a final concentration of 20 per cent. On leaving overnight at 0° C., microscopic green crystals of the chlorophyll-protein complex separated in rosettes. These were recrystallized from α -picoline and dioxan mixture. The material formed roughly equidimensional clusters, each appearing to have grown dendritically from a centre.

Chlorophyll was extracted from the complex by organic solvents, and the absorption spectrum of a solution of the pigment in ether indicated the presence of chlorophylls *a* and *b*. The usual amino-acids were detected by paper chromatography in a hydrolysate of the complex.

Similar crystals were also obtained from a species of marine *Chlamydomonas* kindly provided by Dr. C. P. Spender. In contrast, the above procedure failed to extract any coloured material from intact cells of *Chlorella vulgaris*, grown with either carbon dioxide or glucose as source of carbon.

We wish to thank Dr. L. Fowden for the culture of *Chlorella* and the Agricultural Research Council for financial support.

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Separation and Estimation of Chitosamine and Chondrosamine in Complex Hydrolysates

THE estimation of hexosamines in hydrolysates of complex biological materials, containing both protein and carbohydrate parts, has for some years been recognized as one of the more important analytical problems of biochemistry. The separation and identification of the two hexosamines, chitosamine (glucosamine) and chondrosamine (galactosamine), known to occur in the animal organism, is likewise difficult. The use of ion-exchange resins offers a convenient technique for separating the hexosamines from each other and from other substances.

Moore and Stein¹ report the position of a hexosamine peak using elution chromatography with both 100-cm. and 15-cm. columns of 'Dowex 50' resin. Partridge and Elsdon² have separated chitosamine from chondrosamine on 100-cm. columns of 'Dowex 50'; the peaks emerge in the region 250-350 fractions from the beginning of the run where the citrate buffer of pH 4.25 is emerging. Unfortunately, the hexosamine peaks overlap some of the amino-acid peaks, necessitating the analysis of alternate fractions by the ninhydrin³ and the Elson and Morgan⁴ methods, respectively, to enable a distinction to be made. In addition, we have found the position of the peaks

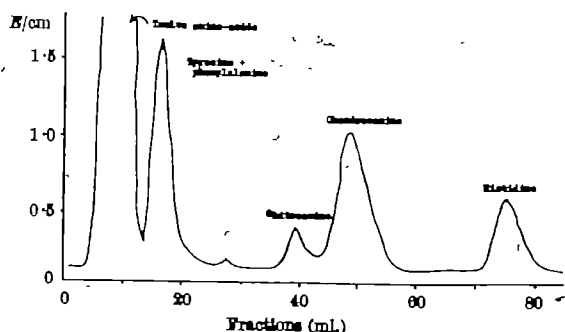


Fig. 1. A portion of a chromatogram of a protein-carbohydrate complex hydrolysate on a 15-cm. column of 'Dowex 50', showing separation of the hexosamines

liable to vary somewhat according to an unknown factor, possibly the flow-rate. Gardell⁴ has separated glucosamine from galactosamine on 'Dowex 50' columns using 0.3 *N* hydrochloric acid as eluant, and Boas⁵ used the same resin to remove interfering substances from hexosamine solutions. Both authors utilized modified Elson and Morgan⁶ techniques to determine the hexosamines.

Recently, in connexion with the analysis of a protein-carbohydrate complex isolated from compact bone, we have succeeded in separating chitosamine and chondrosamine quantitatively on 15 cm. $\times$ 0.9 cm. columns of 'Dowex 50' using the standard procedure of Moore and Stein¹. The positions of the peaks are shown in the accompanying figure, where the optical density of the solution, compared with water, is plotted against the fraction number. The chitosamine peak at fraction 40 is well separated from the chondrosamine peak at fraction 50. The hexosamine peaks are also separated from tyrosine and phenylalanine, from the amino-acids emerging before these and from the small peak at fraction 25, which is an artefact arising from the change of buffer at fraction 23 (0.1 *M* sodium citrate, pH 4.95 to 0.1 *M* sodium phosphate, pH 6.75). Histidine and hydroxylysine (not shown in the figure) emerge after the hexosamines and without overlap. The only known amino-acid emerging with the hexosamines is tryptophan, which is unlikely to cause difficulty in hydrolysates, since it is completely destroyed on heating with acid.

The complete separation of the hexosamines from amino-acids on the 15-cm. column enables the reliable ninhydrin procedure² to be used for estimation in place of the less accurate method of Elson and Morgan⁶. Convenience is also gained, compared with the use of the 100-cm. column, since a smaller number of fractions is required for the emergence of the amino-sugars. Both chitosamine and chondrosamine give the same colour intensities with ninhydrin as an equimolecular weight of leucine, that is, colour yield is 1.00%. Both hexosamines were recovered quantitatively from the column, when added as the pure hydrochlorides. The method, therefore, provides an accurate means of determining small quantities of chitosamine and chondrosamine in hydrolysates of complex polysaccharides, whether or not proteins are also present. The decomposition of hexosamines, in the presence of amino-acids, under the initial hydrolysis conditions has not been fully investigated. More than 98 per cent of the total nitrogen, as shown by the ninhydrin-positive components, was recovered from a protein-carbohydrate complex, which contained 8 per cent of hexosamines and more than 60 per cent of amino-acids, after 0.05 gm. was

hydrolysed with 10 ml. of 20 per cent w/w hydrochloric acid at 100° for 24 hr. It would thus appear that the amount of breakdown is small when a large excess of acid is used for hydrolysis.

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Cleavage of the 2:4-Dinitrophenylhydrazones of Ketones

THE interesting contribution of J. Demaecker and R. H. Martin¹ on this subject prompts me to mention an alternative method which was devised in the course of work (1946) in the strychnine series.

The ketone 4-nitrophenylhydrazone or 2:4-dinitrophenylhydrazone was heated on the steam-bath with 80 per cent formic acid (or stronger) and copper carbonate added. The end-point was in most cases indicated by the disappearance of colour. In this process the nitro- or dinitro-phenylhydrazine produced by hydrolysis is destroyed by oxidation, and, however unfavourable the equilibrium between hydraxine and hydrazone may be, the liberation of ketone goes to completion. The method was found to be generally applicable, and the yields of ketone were high.

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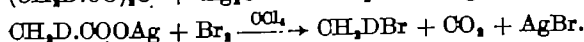
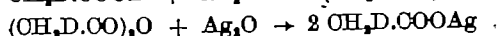
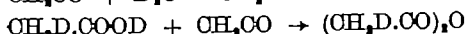
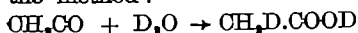
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Preparation of Monodeuteriomethyl Bromide

THE exchange of deuterium and hydrogen has prevented the attainment of a high degree of isotopic purity in the preparation of compounds of the type CH_2DX , where X is a halogen atom or hydroxyl group. CH_2DOD has been prepared by the action of diazomethane on heavy water. Halford *et al.*¹ acidified the D_2O with SO_2 . No exact indication of the isotopic purity of the product was obtained². Langseth and Bak³ claimed that about 10 per cent CH_3OH was present in CH_2DOD prepared by the same method due to water unavoidably present in the CH_3N_2 . Beersmans and Jungers⁴ repeatedly bubbled gaseous CH_3N_2 through D_2O until reaction was complete. The product was a mixture of all the different isotopic forms. Without acidification the reaction may proceed by a free radical mechanism⁵ leading to exchange. The methyl bromide prepared by esterification with HBr (in which no exchange occurs) contained 51 per cent CH_2DBr and CHD_2Br ⁶.

I prepared CH_2DBr in about 93 per cent isotopic purity by the direct action of CH_3N_2 and DBr in dibutyl ether⁷. The reagents are difficult to handle on a large scale, and it does not seem possible to avoid exchange with such reactive materials.

CH_3DBr has now been prepared in high yield by the method:



Ketene was prepared in the standard way⁸ and bubbled directly through D_2O . The acetic anhydride, after fractional distillation, combined directly with dry Ag_2O . The method of Bockmuller and Hoffman⁹ was followed in the bromination.

Mass-spectrometric analysis indicated about 5 per cent CH_3DBr in the product. This agreed with the analysis of the anhydride and indicated that exchange did not occur in the last steps of the reaction.

Langeath and Bak⁸ prepared $\text{CH}_3\text{D.CO.OCH}_3$ in high isotopic purity by partial acid hydrolysis of dimethyl malonic ester in D_2O followed by decarboxylation of the resultant mono-ester. Silver acetate was prepared from the acid, and the methyl bromide produced by bromination as above was a mixture of CH_3Br , CH_3DBr , CHD_2Br and $\text{CH}_2\text{D}_2\text{Br}$. The exchange was presumed to occur in the last step.

In view of the above results, it is more probable that water, formed in the action of acetic acid on silver oxide, was exchanged with the methyl group of the silver acetate^{10,11}.

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Properties of the Calcium Phosphates

WORKERS on the chemistry of soils and fertilizers have to deal with phosphorus compounds, many of which are complex or of indefinite composition. It is likely that, if fundamental information were available concerning these compounds of fairly well-defined composition, the transformations occurring during manufacture and after application to the soil might be more understandable.

The most widely used phosphate fertilizer is superphosphate, which consists mainly of monocalcium phosphate and calcium sulphate. It depends for its

production upon the use of large quantities of sulphuric acid. Past shortages and doubts concerning future supplies of this acid are among the reasons focusing attention on fertilizers containing more basic phosphates such as dicalcium phosphate, hydroxyapatite and materials of composition between these.

A co-operative programme of work has been commenced in these laboratories aiming in the first instance at establishing the structures of certain calcium phosphates and at developing laboratory techniques permitting an approximate evaluation of their agronomic value.

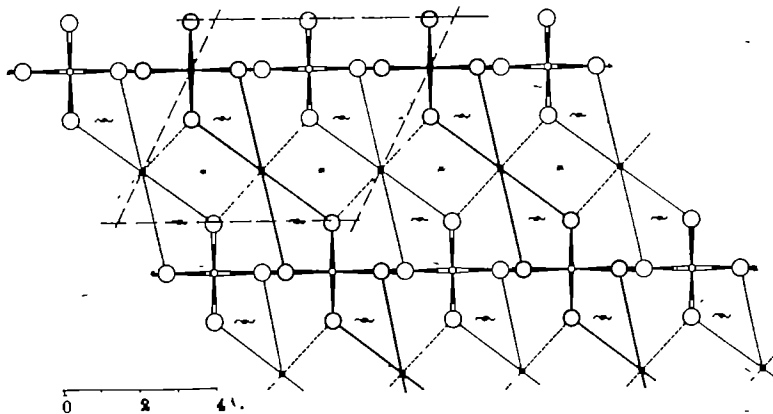


Fig. 1. A sheet of composition CaPO_4 in the structure of $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$

The structures being studied at present are those of $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$ and CaHPO_4 . A forecast that the former structure would be similar to that of gypsum has already been made¹, and we have confirmed the correctness of this by single-crystal X-ray methods.

The unit cell dimensions of $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$ are: $a = 5.812$, $b = 15.180$, $c = 6.239$ Å., $\beta = 116^\circ 25'$. These data correspond to a different choice of a -axis (and of β) from that used by Wooster for gypsum². Wooster's values were apparently taken from Onorato³. The space group of $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$ is $I 2/a$ and the cell contains four formula units. The Ca and P (and probably the H also) are on the two-fold axes, the y parameters of Ca and P differing by exactly a half. These positions of the heavy atoms enable a complete structure determination to be carried out by Fourier methods, and this work has now been almost completed.

In Fig. 1 (a projection along the b -axis), PO_4 groups are represented by oxygen atoms arranged tetrahedrally around the central phosphorus atom. The calcium atoms have six of their eight co-ordination positions occupied by oxygen atoms from PO_4 groups and the remaining two are filled by water molecules. The basic structure can conveniently be regarded as being built of sheets containing parallel chains of composition $=\text{PO}_4=\text{Ca}=\text{PO}_4=\text{Ca}=\text{}$. These run down from left to right in Fig. 1. Adjoining chains in any one sheet differ in height by 2.3 Å. to give a corrugation effect. The higher set of chains is related to the lower by centres of symmetry between the PO_4 groups and between the calcium ions of different molecules. The corrugated sheets themselves are repeated at a separation of $b/2 = 7.59$ Å. by vertical screw axes. Between the sheets are the water molecules, each molecule linking a calcium atom and an oxygen atom in one sheet to an oxygen atom in an adjacent sheet.

The minor differences between the structure of the $\text{CaHPO}_4 \cdot 2\text{H}_2\text{O}$ and $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ are probably associated with the fact that the former is the hydrate of an acid salt. This work will be published in full elsewhere. Our thanks are due to the Research Department of the Tennessee Valley Authority for supplying some materials for this work

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Ignition of Methane-Air Mixtures by Rapid Compression

In an earlier communication¹, the occurrence of bright blue flames by rapid adiabatic compression of methane-air mixtures was reported. Similar observations have recently been reported for methane by other workers^{2,3} using the motored engine technique.

In recent experiments we have improved our original method in which the compression ratio of the motored engine was increased to approach the ignition boundary. A machine of fixed compression ratio of 14.7:1 is now used with an accurately controlled preheat charge temperature. The charge temperature and the mixture composition can be varied with continuous observation of the ignition flame, and in this way the regions of reaction may be charted. The separate regions of blue and yellow flames are clearly distinguished in Fig. 1. It is seen that ignition boundaries have been established at mixture ratios far weaker than have previously been recorded by the motored engine method. A broad and stable region of blue flame has been discovered making possible spectroscopic observation of the light emission. These investigations are proceeding.

A study of the products of reaction has revealed an initial slow reaction for which no radiation has been detected and for which carbon monoxide appears as a delayed product. A boundary for the initial detection of carbon monoxide is shown as the line AB in Fig. 1. Continuous measurement of the composition of the products has shown that the carbon monoxide concentration increases very sharply as the blue ignition limit is approached and that a sharp drop in concentration occurs with the appearance of the blue flames. The lower blue flame boundary is sharp and very reproducible. A similar variation in the products of reaction of weak methane-air mixtures has been found by Burgoyne and Hirsch⁴ using an entirely different experimental method in which the mixture reacts when flowing through a heated tube. The carbon mon-

oxide formed by slow oxidation of the methane has been shown to oxidize rapidly at a sharply defined temperature.

In Figs. 2 and 3 simultaneous pressure and luminosity diagrams are given for typical blue and yellow ignitions. It will be seen that the yellow ignition reaction is early in the cycle and is marked by a steep pressure rise. The blue ignition, at the same temperature, but with a weakened mixture, occurs late in the cycle and shows a less steep rate of pressure rise. The corresponding luminosity diagrams were recorded with a gas-filled photo-cell using an Ilford Spectrum Violet Filter. It is seen that the blue radiation predominates in the yellow ignition flame.

The results now presented show that the blue ignition reactions of methane can occur at very lean mixtures under favourable temperature and pressure conditions. The exact nature of the two modes of ignition is still not clear. It is hoped that, since the cyclic regularity of both blue and yellow ignitions is satisfactory even close to the ignition boundaries, it will be possible to obtain emission spectra and thus elucidate the two mechanisms of ignition.

This work is supported by the Ministry of Fuel and Power.

Note added in proof, February 26. Spectroscopic studies in collaboration with Dr. A. G. Gaydon have now shown that the light emission in the blue region shows a strong continuum of burning carbon monoxide on which a well-defined banded structure is superimposed. This structure has been identified as that

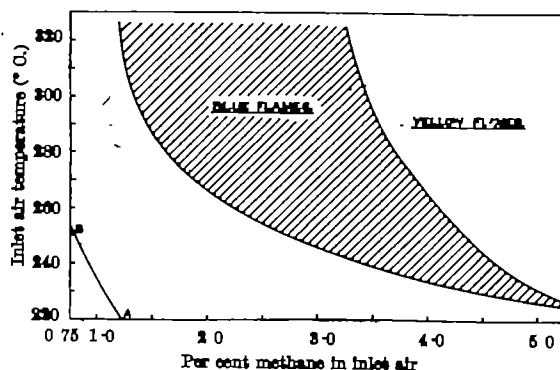


Fig. 1. Ignition boundaries for methane-air mixtures

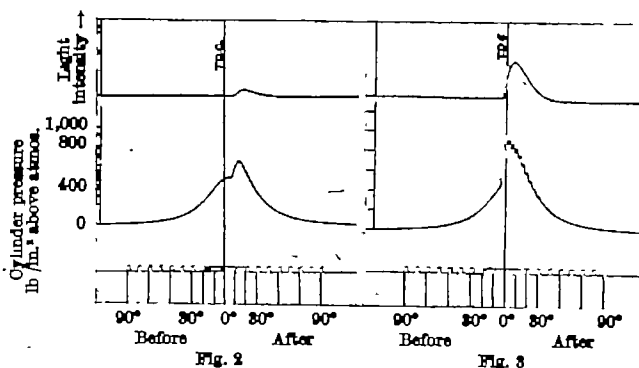


Fig. 2. Blue ignition: 4.04 per cent methane in air; Ignition 6° after top dead centre; rate of pressure rise, 39 lb./in.²/deg. crank angle. Fig. 3. Yellow ignition: 4.67 per cent methane in air; Ignition 4° before top dead centre; rate of pressure rise, 173 lb./in.²/deg. crank angle. Inlet charge temperature, 245° C.; engine speed, 1,000 r.p.m.; water outlet temperature, 60° C.; oil temperature, 40° C.

of excited formaldehyde. Towards the yellow boundary the bands of HCO and OH appear. The spectrum of the yellow region gives a carbon continuum, despite the extreme weakness of the mixture. A full account of the spectroscopic work is in preparation.

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Influence of Cation-Exchange Resins on Adenosine Triphosphate

CATION-EXCHANGE resins provide a convenient means of obtaining free acids from their salts, and the use of resins for obtaining adenosine triphosphate (ATP) from its barium salt has been described¹⁻³.

We have found that ATP which has undergone treatment by a cation-exchange resin behaves unexpectedly when chromatographed on paper. ATP was prepared from Ba₃ATP₄H₂O (Schwarz: New York) by shaking it in aqueous suspension with 'Amberlite IR-120(H)'. When chromatographed according to the method of Burrows, Grylls and Harrison⁴ (solvents 2, 4 and 7), the ATP was located in the position normally occupied by adenosine diphosphate (ADP). Similar anomalous *R_F* values were obtained when a barium salt prepared from ATP (free acid supplied by Light of Colnbrook) was shaken with 'Amberlite IR-120(Na)' or 'IR-100(H)'; or dissolved in acetic or formic acid and passed through a column of 'IR-120(Na)'.

In order to confirm that the resin was responsible for the increase of *R_F* value, aqueous solutions of ATP (Light) were shaken with 'IR-100(H)' or 'IR-120(Na)'. Increased *R_F* values were again found. Similar effects were obtained whether the treated ATP was applied to the paper directly or after evaporation (either as the free acid or in neutral solution) to small bulk at 0° C. under reduced pressure. Under the same conditions the *R_F* values of ADP and adenosine monophosphate were unchanged. Treated and untreated samples of ATP were normally run side by side on the same paper.

Solutions of ATP were prepared from the barium salt (Schwarz) by treatment with sulphuric acid and divided into two parts, one of which was shaken with 'IR-120(H)'. Electrometric titrations showed small significant differences between resin-treated and untreated solutions. Measurement at five-minute intervals of orthophosphate liberated by *N* acetic acid at 100° C. during two hours showed no difference in the hydrolysis-rates of resin-treated and untreated solutions.

A sample of ATP (Light), when chromatographed on paper, gave two well-separated bands, which on elution and analysis were found to have the appropriate total-to-hydrolysable phosphate ratios for

ATP and ADP respectively. The presence of both ATP and ADP in the sample had been previously confirmed by separation on an anion-exchange column according to the procedure of Cohn and Carter⁵. After treatment with 'Amberlite IR-120(H)' resin, paper chromatography of the same sample gave one band only, in the ADP position. When the material from this band was eluted, concentrated by evaporation at 0° C. under reduced pressure and rechromatographed, two bands appeared corresponding to ATP and ADP.

Analogous treatment of the ADP band from an untreated sample of ATP also produced a chromatogram with some material in the ATP position. It is suggested that some samples of ATP may therefore contain two forms of the compound having different characteristics.

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Deoxypentose Nucleic Acid in the Expressible Fluid of Cod Fillets

WHEN fillets of fish are allowed to stand for some time under humid conditions, there is invariably an exudation of a cloudy fluid or 'drip'. If submitted to pressure, the fillets lose fluid ('expressible fluid') at a much faster rate. It has been observed by numerous workers that when the tissue is frozen there is an increase in both the 'drip' and the 'expressible fluid'. A method has been worked out in this laboratory for measuring the amount of 'expressible fluid' that can be obtained from whole fillets cut from fresh and frozen fish. The conditions that are employed are such that it is believed that no appreciable rupture of cells occurs during the time that the fillets are submitted to pressure, and that the exudate consists, therefore, almost entirely of intercellular fluid.

Since deoxypentose nucleic acid (DNA) is found only in cell nuclei, it seemed likely that if any were found in the 'expressible fluid' it would be indicative of cell rupture, with liberation of nuclear material into the interstices. Accordingly, DNA was determined in a large number of samples of 'expressible fluid' obtained from fish treated in different ways. The separation was accomplished with a modified Schmidt-Thannhäuser¹ procedure, and the DNA phosphorus was determined by the method of Berenblum and Chain².

It was found that the 'expressible fluid' from fresh undamaged fillets always contained some DNA (c. 0.12 mgm. DNA phosphorus per 100 ml.) which probably had its origin in nuclear material exuding from the severed cells at the cut surface of the fillets. This view was supported when a large number of fillets was allowed to drain on sloping trays for 24 hours in a saturated atmosphere, without applying pressure. More DNA (c. 0.4 mgm. DNA phosphorus

per 100 ml.) was found in the small quantity of 'drip' obtained than in the 'expressible fluid' from similar fillets. Thus the application of pressure released further fluid of lower DNA concentration, presumably intercellular fluid.

The effect of mechanical damage was illustrated by dividing some similar cod fillets into three groups. The first was pressed under the standard conditions for six hours, the second minced once through a domestic mincer, and the third 'minced' with a domestic mincer and the product put through a Latapie mincer. The two portions of mince were centrifuged at 3,500g for half an hour, and the supernatant fluid poured off. The concentrations of DNA phosphorus were respectively 0.124, 0.380 and 0.807 mgm. per 100 ml. fluid. These results suggest that, whereas the action of a domestic mincer is mostly a tearing apart of the muscle fibres, the Latapie mincer actually breaks the fibres up.

The effect of keeping cod on ice for several days before filleting was small. The DNA-level remained fairly constant from 2 to 9 days, and thereafter showed a small continuous rise, data being obtained up to 16 days. It is suggested that this small rise may be due to the synthesis of DNA by bacteria.

Striking results were obtained when the DNA content of the 'expressible fluid' of fish frozen at different rates was measured. Two effects were shown: (1) In a series of fillets that were frozen more and more quickly, DNA phosphorus levels rose very gradually (from c. 0.2 to 0.3) as freezing-rate increased, and then suddenly rose to a sharp maximum (0.6), falling again to a low level (0.2) as the rate increased further. Microscopic examination of the frozen fish indicated that this maximum corresponded with the entry of ice crystals into the muscle cells.

It has been known for some time that in slowly frozen muscle there are large ice crystals which form between the fibres, whereas in rapidly frozen tissue the crystals are small and within the fibres. This DNA maximum marks the change-over point, where the cooling is just rapid enough to produce intracellular crystals, but where the latter are so big that they rupture the sarcolemmas and liberate nuclear material. As the freezing-rate increases further, the size of the crystals diminishes, leaving the sarcolemmas intact.

(2) When the fillets were frozen very rapidly indeed, as in liquid oxygen and in CO₂-alcohol, there was a further rise in DNA phosphorus concentration to c. 0.5 mgm. per 100 ml. This rise was probably caused by a hard frozen layer forming around the fillet, which tended to prevent the inside from expanding when it froze later, thus setting up a sudden great internal pressure. Fillets frozen more slowly presumably retained a 'cheesy' consistency sufficiently long to permit accommodation to the stresses set up. A similar effect occurred in fillets packed tightly twelve deep in a box and frozen from two opposite faces. The fillets froze from the cooling surfaces towards the centre, and it was found that the fillets at the centre of the box, which were the last to freeze, and which in this instance froze at very slow rates, had high levels of DNA phosphorus in the 'expressible fluid' (c. 0.5 and 0.75 mgm. in two experiments). It is probable that damage to these fillets was caused by their expanding against the restrictions set up by the hard outer masses of the already frozen fish.

It should be emphasized that the fillets were all cooled to the same final temperature, whatever the

rate of freezing, and all were thawed under the same conditions.

It is commonly held that muscle tissue is damaged less and less the more rapidly it is frozen. The results described here indicate that this belief is too simple.

A full account will be published elsewhere.

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A Bacterial Toxin paralyzing Silkworm Larvae

CERTAIN strains of *Bacillus cereus* are among the more virulent known bacterial pathogens of the silkworm, *Bombyx mori* L.¹ Toumanoff and Vago² isolated a strain of *B. cereus* (*B. cereus* var. *alesti*) which causes toxemia, a septicemia and intermediate conditions in silkworm larvae. Another strain of *B. cereus* (*B. cereus* var. *sotto*) was studied by Aoki and Chigasaki³, who suggested that its effect was due to a toxin. A culture of *B. sotto* was kindly made available by Mr. Masatake Ono, of Tokyo, and the disease caused by it has been under investigation in this laboratory since early in 1953.

The work of Aoki and Chigasaki³ has been confirmed. Two conditions have been observed in larvae infested with *B. sotto*: a profound paralysis 2 or 3 hr. after ingestion of old cultures and a septicemia without paralysis 12-24 hr. after injection of spores and cells into the body cavity. The rapid onset of paralysis, which took place without any discernible increase of the ingested bacteria, was suggestive of the presence of a pre-formed toxin; but no toxin could be demonstrated in culture media in which the bacteria had been grown.

It was found in our experiments that treatment of old cultures of *B. sotto* with clarified silkworm gut juice yielded a toxic extract. As silkworm gut juice is normally alkaline (pH 9.5-10.0), an old culture of *B. sotto* was treated with dilute alkali and filtered through a fritted glass filter. The sterile filtrate caused paralysis of silkworm larvae. Hannay⁴ has recently observed alkali-soluble crystalline inclusions in sporulating cells of strains of *B. cereus* known to be pathogenic for insect larvae. Microscopical examination of *B. sotto* revealed similar crystals. Treatment of a suspension of spores, crystals, and vegetative debris with alkali resulted in the dissolution of the crystals without affecting the viability of the spores.

An experiment was done to test whether there might be any foundation to the speculation made by Hannay⁴ that the crystals might be a toxic substance encouraging septicemia of the insect larvae. A suspension of crystals, spores and vegetative debris of *B. sotto* was well washed by centrifugation, resuspended in water, and divided into two parts. One part was diluted and tested against silkworm larvae both by injecting a quantity of it into the body cavity and by feeding. The second part was treated with alkali until the crystals had dissolved, then the spores and debris were centrifuged out, well washed by centrifugation and resuspended in water. A

THE EFFECT OF FEEDING AND INJECTING LARVAE OF *Bombus mori* L. WITH FRACTIONS OF AN ALKALI-TREATED CULTURE OF *B. sotto*

	Method of dosing larvae	
	By feeding	By injection
<i>Original culture</i> Spores and crystals (1×10^8 spores per larva)	Paralysis within 4 hr., septicemia within 12 hr.	Septicemia within 12 hr. No paralysis
<i>Alkali-treated culture</i> 1. Spore fraction (1×10^8 spores per larva)	No effect	Septicemia within 12 hr.
2. Supernatant	Paralysis within 4 hr. No septicemia	No effect
3. Supernatant dialysed	Paralysis within 4 hr. No septicemia	No effect
4. Supernatant heated at 70° C. for 30 min.	No effect	No effect

portion of the supernatant was dialysed against water and another portion heated at 70° C. for 30 min. All four fractions were tested by feeding and injection. The results are given in the accompanying table.

The results indicate that the septicemia following feeding is dependent upon the presence of a toxic substance which is heat-labile and non-dialysable. The toxin had a paralytic effect when fed but was non-toxic when injected. The crystal-free spores, on the other hand, were pathogenic when injected but non-invasive when fed.

By differential centrifugation of a suspension of spores and crystals, two fractions were obtained which differed significantly in the ratio of spores to crystals. It was found by feeding various dilutions of the two fractions that toxicity varied as the crystal count and was independent of the number of spores present.

The results presented above indicate that the toxic component in old cultures of *Bacillus sotto* responsible for paralysis in silkworm larvae is associated with the crystalline inclusions described by Hannay. The investigation of its nature and mode of action is being continued.

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Buds on the Roots of the Rosebay Willow-herb (Fireweed)

SEVERAL investigators have previously recorded the presence of buds on the roots of the rosebay willow-herb or fireweed (*Chamaenerion angustifolium* (L.) Scop.)¹⁻⁴, and the purpose of the present work was to obtain a more complete picture of the formation of these root buds.

On the surface of the roots of *Chamaenerion* are small pit-like depressions. These depressions mark the position of the root traces on secondarily thickened roots in their first year of growth; but according to Moes⁵ in older roots with one or more interxylary periderms the depressions result from the disorgan-

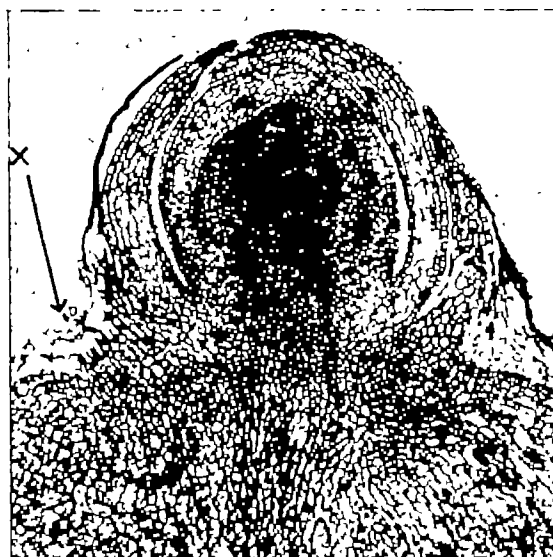


Fig. 1. A root bud of *Chamaenerion angustifolium* (L.) Scop. in the proximity of a root trace (at X, but not entirely in the plane of the section). The bud has ruptured the outer tissues of the periderm. ($\times 75$)

ization of young buds and lateral roots. Buds and lateral roots originate within the proximity of these depressions, and in order to obtain a succession of stages in the formation of lateral roots and buds the depressions were first marked with indian ink and root cuttings, several centimetres long, grown in a constant-temperature room ($21^\circ \pm 1^\circ$ C.) on filter paper kept moist with distilled water. Every other day one or two cuttings were removed and microtome sections cut in the region of the depressions. Unfortunately, very early stages in bud formation could not be detected with certainty since the buds originated from tissues which were already meristematic. However, it has been found that they are endogenous in origin and arise from the external phellogen and its immediate derivatives (Fig. 1). Lateral roots also originate from the external phellogen and its immediate derivatives, and like the buds they are endogenous and rupture the outer tissues of the periderm as they emerge.



Fig. 2. Stages in bud formation at the distal cut surfaces of decapitated buds: (a) camera lucida drawing of initial activity involving cells just below the cut surface ($\times 527$); (b) the adjacent cells above the meristem have ruptured ($\times 120$); (c) later stage in bud formation ($\times 80$)

Root cuttings produced not only buds and roots but also small green hemispherical mounds. After a few days, shoots, a number of which were fasciated, and very occasionally roots, developed from these mounds. Microtome sections revealed that the mounds developed from the distal out surface of decapitated buds. The first indication of the formation of a bud meristem was seen in a group of deeply stained cells just below the surface of a mound. At this stage only a few cell layers were involved (Fig. 2a); but gradually the tendency to become meristematic extended inwards. As the meristem increased in size a tunica and corpus became distinguishable and ultimately the adjacent cells above ruptured, disintegrated and the meristem became freely exposed on the surface of the mound (Fig. 2b). Leaf primordia were later formed and prevascular strands differentiated downwards to the cambium of the decapitated bud (Fig. 2c). These buds are therefore endogenous in origin, as are the roots which very occasionally develop from these mounds. This contrasts with the origin of the shoot buds which are exogenous in *Chamaenerion*.

These findings are in agreement with those of previous investigators who have shown that, though occasionally endogenous, shoot buds of vascular plants are exogenous whereas root buds are endogenous¹⁻³, and the question arises as to the nature of the factors involved in determining whether a particular meristem becomes that of a root or a shoot. The results of some preliminary experiments indicate that auxins and wound hormones are involved in determining the future development of a meristem in the root cuttings of *Chamaenerion*, and further studies are being made along these lines.

I wish to express my gratitude to Prof. C. W. Wardlaw and Dr. A. Allsopp for their guidance and encouragement throughout this investigation, and to Mr. Ernest Ashby for the photographic illustrations.

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four branches, $2n = 36$; *Salicornia disarticulata* Moes, $2n = 16$ (?).

These counts are original, the tetraploid number of $2n = 36$ agreeing with a similar count obtained by Ludwig⁸ for *S. europaea* L. (*S. stricta* Dum. sec. Moes) from the north coast of Europe. A count for the same species from the Wetterau district is given in the same paper as $2n = 18$.

Illustrations of habit specimens corresponding with these counts will appear elsewhere.

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Action of Peptone on Mast Cells of the Dog

ALTERATIONS of mast cells in the liver of dogs submitted to peptone shock were described by Wilander¹; Jaques and Waters² have confirmed Wilander's results and found similar changes of the mast cells in anaphylactic shock. These alterations have been related by these authors to heparin liberation.

Riley and West³ and Riley⁴ observed a striking correlation between mast cells content of a tissue and its concentration of histamine. In addition, Riley⁵ and we⁶ verified disruption of mast cells in conditions in which histamine liberation occurs. These papers suggest that mast cells might be a source of histamine in animal tissue.

Recently, Lecomte and Baecckeland⁷ could not duplicate Wilander's findings, observing no changes in dog liver mast cells after peptone shock. Our recent experiments support Wilander's results.

The effect of peptone on the mast cells was studied in ten dogs injected intravenously with 0.5 gm. per kgm. of peptone, in which blood pressure and clotting time were determined. Liver biopsies were made before and after the peptone shock. Experiments performed in order to obtain an adequate technique for the preservation of dog mast cells showed that aqueous fixatives and paraffin embedding must be avoided. Good results were obtained only with a 4 per cent solution of lead sub-acetate in 50 per cent alcohol, and this was used throughout. Frozen

Chromosome Numbers in British *Salicornia*

COUNTS so far obtained of the chromosomes of *Salicornia* species indicate the basic number $x = 9$. British material examined from localities on the estuary of the River Medway has yielded the following counts: *Salicornia perennis* Mill. var. *radicans* Moes and Salisbury in "Camb. Brit. Fl.",¹ $2n = 18$; *Salicornia ramosissima* Woods, form agreeing closely with the habit illustration in "Camb. Brit. Fl.", $2n = 18$; dwarf red form, $2n = 18$; *Salicornia stricta* Dum. sec. Moes, form agreeing closely with the illustration in "Further Illustrations of British Plants"² of *S. europaea* L., $2n = 36$; *Salicornia dolichostachya* Moes, erect form with long tapering fertile branches; upper nodes each bearing

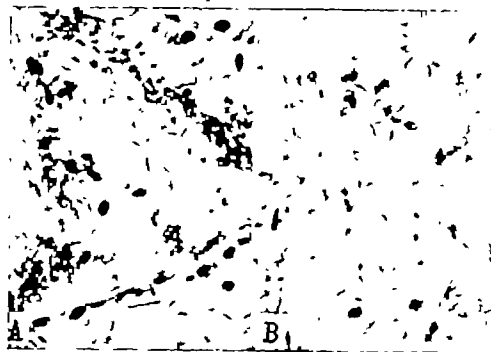


Fig. 1. Mast cells in the connective tissue of dog's tongue, using Ehrlich's thionin stain ($\times 800$). (A) from control animal; (B) from dog after peptone shock. Note degranulation and reduction of metachromasia of remaining granules.

sections, 50 μ thick, stained by Ehrlich's thionin, were studied. In these conditions, not only Wilander's observations concerning the effect of peptone shock on liver mast cells could be confirmed, but it was also observed that mast cells of other organs (tongue, spleen, mesentery, lung, etc.) presented identical changes. In the tongue, an organ particularly rich in mast cells, these changes are easily observed (Fig. 1). Peptone shock induces a significant decrease in the number of mast cells and promotes a degranulation and reduction of metachromasia of the remaining granules. These alterations seem to depend on the local concentration of peptone, since we have observed that when the peptone solution is injected directly into the lingual artery the mast cells of this organ present exceptionally intense changes. This fact, and our observations that mast cells of other organs also present alterations, suggest that in the dog, heparin and histamine might originate from other organs besides the liver. A detailed account of these results will be published.

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range 6.8-7.2 are optimal. The effect is entirely abolished by 0.3 mM calcium chloride. Over a wide range the activity of the preparations as myokinase and their activity as a relaxing factor go hand in hand. The evidence suggests, however, that in its role as relaxing factor myokinase is acting in a way which cannot be explained simply in terms of its ability to resynthesize adenosine triphosphate, and that it probably takes part in a more complex reaction, when actomyosin and the adenosine nucleotides are present.

Thus, the effect of the original factor of Marsh can be explained in terms of its myokinase activity; but it is quite out of the question to explain it in terms of creatine phosphokinase, since (a) the conditions of preparation and use of the factor preclude the possibility of the presence of creatine phosphate in the system; and (b) the effect is optimal in the normal physiological pH range, 6.8-7.2, and is diminished in the range 6.0-6.5.

The work described in this paper was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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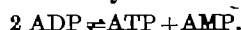
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Myokinase as a Relaxing Factor in Muscle

LORAND¹ has recently shown that relaxation of muscle-fibre models will occur when 10 mM creatine phosphate, 5 mM adenosine triphosphate and an enzyme preparation of muscle are added to them. The enzyme (adenosine triphosphate-creatine transphosphorylase) is probably identical with Lohmann's enzyme, creatine phosphokinase². Relaxation occurs only at low pH (6.2 or below), whereas the fibres shorten or develop tension at higher pH values. Magnesium ions (1 to 2 mM) are necessary for the relaxation which is inhibited by calcium ions. Lorand suggests that the effect is due to resynthesis of adenosine triphosphate, as fast as it is broken down by the fibres, by virtue of the reaction:



This is known to go to the right at pH values below 6.5³. He suggests further that any system capable of resynthesizing adenosine triphosphate would act in the same way and, in particular, that myokinase would do so, since it catalyses the reaction:



I have, in fact, been able to show, in a paper submitted for publication in December of last year⁴, that myokinase does indeed bring about relaxation of muscle-fibre models, and that it is indistinguishable in its effect from the relaxing factor of Marsh⁵. For full-activity magnesium ions (4 mM), an ionic strength between 0.10 and 0.20, and a pH in the

Coenzyme of Kidney Phosphatase

In previous communications¹ we advanced a hypothesis supporting the nucleotide nature of kidney phosphatase. Kutscher and Schreier² also consider phosphatases as metal proteins, and they attribute the loss in activity which they display on dialysis not only to the elimination of magnesium, but also to the separation of another substance which Kutscher and Sieg³ designate as choline pyrophosphate. In their turn, Akamatsu and Kobayashi⁴ regard histidine as a coenzyme. Recently, however, investigating intestinal phosphatase preparations purified by paper electrophoresis, Roche considers⁵, in view of the results obtained in his analyses, that the hypotheses advanced on the nature of cophosphatase (nucleotide, choline pyrophosphate or histidine) are scarcely probable.

So far as we are concerned, the results obtained in the course of recent experiments still support our interpretation. As a matter of fact, the phosphatase by extraction with trichloroacetic acid, in order to separate the protein portion, and subsequent hydrolysis with baryta, gave solutions which were chromatographed on Whatman No. 1 paper with the object of characterizing the nucleotide. We employed the 2 N HCl-isopropanol mixture which Wyatt recommends⁶ and developed the chromatogram in the presence of ultra-violet light, employing a quartz lamp fitted with a Corning 9863 filter (240-400 m μ). A spot, the R_F of which is close to that of uridylic acid, was thus obtained. Once that portion of paper which

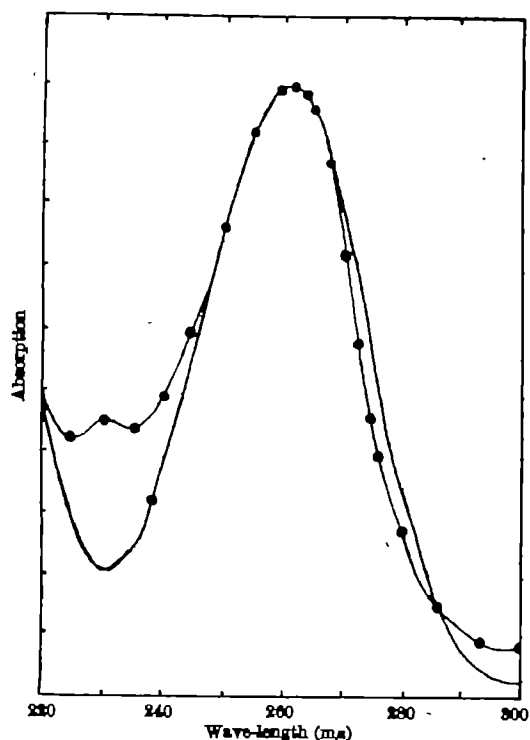


Fig. 1. Absorption curves: ●—●, phosphatase; ○—○, uridylic acid (Plesser and Loring, *J. Biol. Chem.*, 178, 431; 1949)

corresponds to the phosphatase spot in the chromatogram had been separated we obtained, after eluting with 0.01 N HCl, the spectrum shown in Fig. 1 (with a maximum of 261 mμ), falling in with that of uridylic acid, which appears superimposed.

It is evident that, despite this result, the lack of a purity guarantee in the phosphatase preparation we employed is a factor of a weight sufficient to prevent us from affirming that uridylic acid is a component of the former. In order to ascertain, in so far as feasible, its participation in the structure of phosphatase, we proceeded to inoculate rats and rabbits with a precursor of uridylic acid, orotic-2-¹⁴C acid¹, with the object of investigating the possible presence of ¹⁴C in the kidney phosphatase of the inoculated animals as well as its relationship to enzymatic activity. The results obtained are reproduced in the accompanying table.

The results reveal that a variation in the enzymatic activity of the preparation (percentage P) is attended by a variation in counts/min. practically

No of experiment	Phosphatase preparation	Radioactivity		Enzymatic activity	
		c./m.	% Δ	% P hydrolysed	% Δ
1	a	1,370		19.8	
	a ₁	1,900	35	27.8	35
	b	inestimable		0.64	
2	a	1,430		24.8	
	a ₁	2,000	39	33.8	36
	b	420	-80	4.9	-85

a, According to Albers².

a₁, According to Albers² purified by reprecipitations with acetone.

b, Precipitated by alcohol from the enzymatic solution after separating a.

checking in percentage. This permits us to attribute both effects to the same substance.

Once the radioactive phosphatase has been hydrolysed under conditions identical with those in previous experiments and the chromatogram developed, the portion of paper corresponding to the uridylic acid stain was cut away while the rest of the chromatogram was cut into several pieces. All these were eluted with 0.01 N HCl before evaporating to dryness and counting in the Geiger-Müller counter. As Fig. 2 shows, the portion corresponding to uridylic acid displayed a marked radioactivity, and only that part contiguous to it was radioactive but in a much lesser scale. The protein fraction separated by trichloroacetic acid displayed no radioactive activity at all. All the carbon-14 in phosphatase is therefore present in uridylic acid. As, on the other hand, the table permits us to refer enzymatic activity to this same substance, it seems probable that uridylic acid is a component of kidney cophosphatase.

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Nov. 30.

¹ Lora-Tamayo, M., and Munioz, A. M., *Nature*, 168, 248 (1951); *Enzymologia*, 24, 377 (1953). Lora-Tamayo, M., and Baluja, G., *Bull. Soc. Chim. Biol.*, 35, 231 (1953).

² Kutischer, W., and Schroter, *Naturwissenschaften*, 35, 255 (1948).

³ Kutischer, W., and Sleg, H., *Naturwissenschaften*, 37, 451 (1950).

⁴ Akamatsu, S., and Kobayashi, K., *Enzymologia*, 18, 154 (1952).

⁵ Roche, J., and Bouchillout, S., *Bull. Soc. Chim. Biol.*, 35, 567 (1953).

⁶ Wyatt, G. B., *Biochem. J.*, 43, 534 (1951).

⁷ Lora-Tamayo, M., Gamboa, N. M., and Alvarez, Eldiherito F., *Anal. Fis. y Quím.*, 43, B, 889 (1952).

⁸ Albers, H., and Albers, H., *Z. physiol. Chem.*, 232, 180 (1935).

X-Ray Analysis of the Structure of Peripheral Nerve Myelin

THE low-angle diffraction pattern of fresh sciatic nerve of frog takes a relatively simple form, showing only six equatorial reflexions, five of which can be accounted for as successive orders of diffraction from a radially oriented fundamental structural unit measuring 171 Å.^{1,2} These five reflexions display striking variations in intensities as indicated in Fig. 1a, and from this intensity data a Patterson distribution (variation of $P = F^2_{(hkl)} \cos 2\pi ls$) along a line in the radial direction in the sheath has been calculated (Fig. 1a).

In earlier experiments on the modification of nerve myelin³⁻⁵, it was observed that a relatively slight drying of the nerve specimen produced a marked increase in the intensity of the third-order diffraction and a decrease in the intensities of the higher orders.

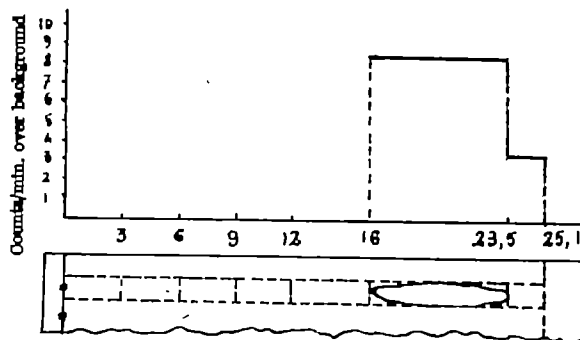


Fig. 2. Counting of chromatogram. Horizontal axis of histogram is in cm.

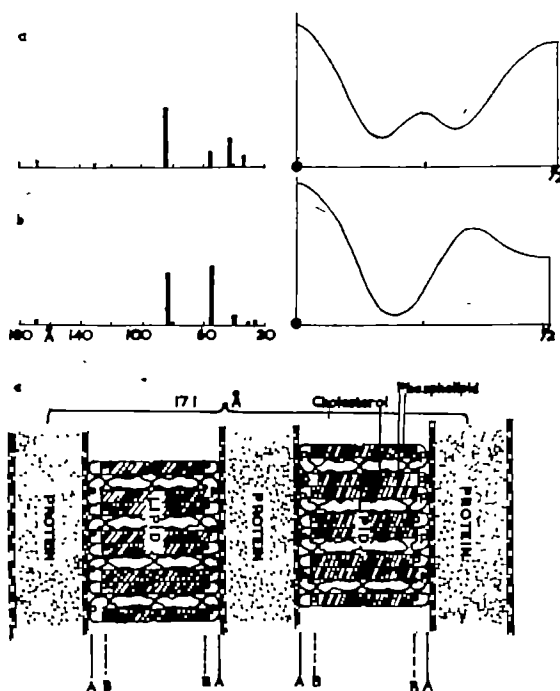


Fig. 1. Low-angle diffraction data and corresponding one-dimensional Patterson distributions for (a) fresh frog sciatic nerve; (b) nerve immersed in Ringer's solution of ten times normal concentration for twenty-four hours; (c) suggested general scheme of molecular organization within the unit cell of fresh peripheral nerve myelin indicating levels A and B at which peak electron densities might be expected. The approximate positions of phosphate groups in phospholipid molecules are marked with the letter P.

These changes were accompanied by a small reduction (c. 5–6 Å.) in the fundamental spacing, and were reversible. A similar effect (Fig. 1b) was obtained under more readily controllable conditions by immersing the nerve in Ringer's solution of greater than normal concentration⁴.

The net effect on the Patterson diagrams of this modification is to replace the interaction at a quarter by a much stronger interaction at one-third of the unit cell dimension.

Other modifications^{2,5} of the nerve myelin were found to lead eventually to the disappearance of the odd orders of diffraction. Such modifications were irreversible.

In spite of the apparent chemical complexity of myelin, it is possible that the striking diffraction effects observed have a relatively simple explanation in terms of the general arrangement of molecules within the unit cell and the specific placing of a few atoms or groups of atoms of outstanding diffracting power. In previous considerations of the structure of myelin^{2,7,8}, molecular arrangements based on an alternation of lipid layers and protein layers have been suggested which would account for the tendency towards 'halving' in the 171-Å. dimension of the unit cell. The observations on the changes in pattern accompanying slight dehydration seem to be explained most readily on the general assumption that two sets of closely spaced groups of high diffracting power are responsible for the interactions, one set being separated by a quarter in the fresh myelin and the second set by a distance just greater than one-third. The shrinkage of the fundamental structural unit in the initial reversible stage of drying may be sufficient to reduce the separation of the first set of groups so

that they can no longer reinforce the fourth-order diffraction, and at the same time to bring the second set of groups into a position for reinforcing the third and sixth orders.

A recent suggestion of a detailed spatial arrangement of phospholipid and cholesterol molecules in the lipid layers of myelin^{9,10} immediately indicates two sets of levels at which peaks in the electron density distribution in the radial direction might be expected. These peaks are associated in part with the phosphate groups of the phospholipids which, in a lipoprotein structure consisting mainly of carbon, nitrogen, oxygen and hydrogen, might be expected to provide centres of outstanding electron density. Fig. 1c shows a schematic arrangement of components in the unit cell of nerve myelin in terms of which it is possible to give a qualitative explanation of the intensities of the various reflexions. For simplicity, the positions of the electron density peaks have been made identical in the two parts of the unit cell, and therefore different 'scattering factors' must be given to these levels to account for the intensities of the odd orders of diffraction. The longest phospholipid molecules are associated with the cholesterol in such a way that the phosphate group (P) of the former is brought into close association with the protein at the interface A, which may also contain metallic ions. This interface would thus be expected to provide one of the levels of high electron density, and is suggested to occur at or near $0, \frac{1}{4}, \frac{1}{2}$ and $\frac{3}{4}$ in the unit cell of slightly dehydrated myelin. With the type of spatial arrangement of phospholipid and cholesterol molecules shown in Fig. 1c a second level of high electron density might be expected to occur in the lipid layer at a distance of about 4–6 Å. from the interface, where the terminal groups of the curled phospholipid molecules come into association with the cholesterol, and in the case of phosphatidyl serines possibly also with metallic ions. The phosphate groups of any fully extended phospholipid molecules would also be expected to occur at this level, B, which is suggested to be at $0, \frac{1}{4}, \frac{1}{2}, \frac{3}{4}$ in the unit cell of fresh myelin.

Rough Fourier calculations have indicated the possibility of obtaining the right sequence of intensities for the various orders of diffraction in terms of these sets of electron density peaks; but two main factors hinder the detailed quantitative correlation. The molecular picture is not yet sufficiently detailed to permit the reliable prediction of the relative heights of the suggested electron density peaks, and the correction factors which must be applied to the measured intensities from this type of liquid crystalline system are not yet known.

J. B. FINEAN

Department of Pharmacology,
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Dec. 4.

- ¹ Schmidt, F. O., *Multiple Sclerosis and the Demyelinating Diseases*, 28, 247 (1950).
- ² Finean, J. B., *Exp. Cell Res.*, 5, 202 (1953).
- ³ Milnes, J., and Finean, J. B., *Farad. Soc. Disc.*, No. 6 (Lipoproteins), 134 (1949).
- ⁴ Milnes, J., and Finean, J. B., *Exp. Cell Res.*, 4, 60 (1953).
- ⁵ Milnes, J., and Finean, J. B., *Exp. Cell Res.*, 4, 82 (1953).
- ⁶ Unpublished results.
- ⁷ Schmidt, F. O., *Z. wiss. Mik.*, 54, 150 (1937).
- ⁸ Schmidt, F. O., Bear, B. S., and Palmer, K. J., *J. Cell. Comp. Physiol.*, 18, 21 (1941).
- ⁹ Finean, J. B., *Internat. Colloquium on Biochemical Problems of Lipids*, Brussels, 1953 (in the press).
- ¹⁰ Finean, J. B., *Experientia*, 9, 17 (1953).

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, March 22

BONE AND TOOTH SOCIETY (at the Institute of Orthopaedics, 234 Great Portland Street, London, W.1), at 5 p.m.—Symposium on "Hereditary Skeletal Disease". Prof. L. S. Penrose: "Genetics and Bone Disease"; Dr. H. Grönberg: "Genetics and Bone Disease in Animals"; Dr. H. Harris: "Genetics of Rickets and Osteomalacia".

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 6 p.m.—Mr. J. F. M. Middleton: "Oxford University Expedition to Uganda".

ROYAL INSTITUTE OF CHEMISTRY, LONDON SECTION (at Darford Technical College, Lowfield Street, Darford, Kent), at 7.30 p.m.—Dr. J. M. Fletcher: "Chemical Problems Associated with Nuclear Reactors".

Monday, March 22—Friday, March 26

CERA FOUNDATION FOR THE PROMOTION OF INTERNATIONAL CO-OPERATION IN MEDICAL AND CHEMICAL RESEARCH (at 41 Portland Place, London, W.1).—Symposium on "The Chemistry and Biology of Pteridine".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.0.2).—Bicentenary Celebrations.

Tuesday, March 23

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. H. Heywood: "Solar Energy for Water-and-Space-Heating".

UNIVERSITY OF LONDON (in the Anatomy Theatre—Communication Research Centre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Sir Geoffrey Vickers: "Communication in Economic Systems".

INSTITUTE OF ELECTRICIAL ENGINEERS, EDUCATION DISCUSSION GROUP (at Savoy Place, London, W.C.2), at 6 p.m.—Mr. F. A. Meier: "An Experimental and Theoretical Approach to the Teaching of Electromagnetism using the Rationalized M.K.S. System of Units".

SOUTH PLAINS ETHICAL SOCIETY (at Conway Hall, Red Lion Square, London, W.C.1), at 7.30 p.m.—Dr. J. Bronowski: "The Fulfilment of Man" (Conway Memorial Lecture).

Wednesday, March 24

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Ben Lockspeiser, F.R.S.: "Manufactures, 1754-1954". (Special Bicentenary Lecture.)

PHYSICAL SOCIETY, COLOUR GROUP (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.15 p.m.—Fourteenth Annual General Meeting. 3.30 p.m.—Miss P. W. Trezona: "Additivity of Colour Equations". Dr. G. S. Brindley: "The Number of Kinds of Human Retinal Receptors and the Spatial and Temporal Summation and Resolution allowed by their Pathways".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. Colin Clark: "World Supply and Requirements of Farm Products".

ENGINEERS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. M. Tanner: "Physique and Choice of Career".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP—NUTRITION PANEL (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Annual General Meeting.

ROYAL INSTITUTE OF CHEMISTRY (Joint meeting with the LONDON SECTION of the SOCIETY OF CHEMICAL INDUSTRY, at the Institute of Metals, Grosvenor Gardens, London, S.W.1), at 6.30 p.m.—Prof. A. B. J. P. Ubbelohde, F.R.S.: "Some Recent Advances in Physical Chemistry".

WOOD EDUCATION SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 7 p.m.—Sir John Lennep: "Growing Wood in Victoria".

CHADWICK PUBLIC LECTURE (in collaboration with the Leeds City Council, in the Museum Lecture Theatre, Park Row, Leeds 1), at 7.30 p.m.—Prof. S. B. Finer: "Edwin Chadwick and the Conquest of Disease 1843-1953".

Wednesday, March 24—Friday, March 26

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMERS GROUP (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2).—Symposium on "The Chemistry and Physics of Synthetic Fibres".

Thursday, March 25

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. G. R. Goldsbrough, F.R.S.: "Wind-effects on the Motion of the Sea in an Infinite Channel and in a Rectangular Gulf"; Mr. N. M. Bider: "Bddy Diffusion of Momentum, Water Vapour and Heat Near the Ground".

INSTITUTE OF MECHANICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. F. L. Lawton: "The Kamano Hydro-Electric Development and Associated Kinmat Aluminium-Reduction Works".

TELEVISION SOCIETY (at the Cinematograph Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Mr. R. J. Boddy and Mr. O. D. Gardner: "An Industrial Television Channel".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. H. J. Smolens, F.R.S.: "Organometallic Compounds Containing Fluorocarbon Radicals" (Liveridge Lecture).

Thursday, March 25—Friday, March 26

NATIONAL ASSOCIATION FOR MENTAL HEALTH (at Friends' House, Euston Road, London, N.W.1), at 10 a.m. daily—Annual Conference—"Strain and Stress in Modern Living: Special Opportunities and Responsibilities of Public Authorities".

Friday, March 26

INSTITUTE OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 10.30 a.m.—Conference on "Hydraulic Mechanisms".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion. Speakers: Dr. J. M. Bruckshaw, Dr. A. H. Cook, F.R.S., Sir Harold Jeffreys, F.R.S., and Dr. S. K. Runcorn. Chairman: Dr. R. Stonley, F.R.S.

PHYSICAL SOCIETY (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Sir Geoffrey Taylor, F.R.S.: "Diffusion and Mass Transport in Tubes" (38th Guthrie Lecture).

ROYAL INSTITUTE (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. F. A. Paneth, F.R.S.: "The Chemical Exploration of the Stratosphere".

Saturday, March 27

BRITISH SOCIOLOGICAL ASSOCIATION (in the Herringham Hall, Bedford College, Regent's Park, London, N.W.1), at 4.30 p.m.—Prof. W. J. H. Sproul: "Theory and Practice".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (with good university degree or equivalent, with considerable teaching and industrial or research experience) in AIRCRAFT STRUCTURES, to teach to Final B.Sc. and H.N.O. standard.—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (March 26).

LECTURER IN PHYSICS—The Secretary, Brickbeek College, Malet Street, London, W.C.1 (March 26).

METALLURGIST (with an honours degree in metallurgy and some experience in metallurgical research, and preferably with experience in the use of X-ray equipment) at the B.I.S.R.A. Laboratories in Swansea.—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1 (March 26).

COAL CHEMIST (Scientist Grade I) (with first- or second-class honours degree in chemistry, fuel technology or related subjects, and substantial experience of research in the above field) to lead research on the carbonization properties of coal used for smokeless fuel manufacture, Ref. TT/745; **SCIENTIST** (with good honours degree or equivalent, and preferably with general experience in coal chemistry and spectroscopic techniques), for work in the Chemistry Department in connection with infra-red and ultra-violet spectroscopy, Ref. TT/746.—The National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting appropriate Ref. No. (March 27).

SCIENTIST in the Scientific Department of the London Headquarters of the National Coal Board, for work mainly in the hydraulic and mechanical fields, and will include the planning of large-scale experiments and the co-ordination of research data in forms suitable for use by engineers.—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/747 (March 27).

SENIOR LECTURER and a **LECTURER IN PHYSICS** at the University of Natal, Pietermaritzburg, and a **LECTURER IN PHYSICS** at the University of Natal, Durban.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, April 7).

ASSISTANT COAL SURVEY OFFICER (with a good honours degree, or equivalent, in chemistry or fuel technology, and preferably with experience in industry, laboratory control, and the critical assembly of scientific data) at the Coal Survey Laboratory, Sheffield.—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/764 (April 10).

MATHEMATICIANS, Scientific Officer, Experimental Officer and Assistant Experimental Officer grades, in Ministry of Supply Research and Development Establishments, mainly in Southern England, for work including research into aerodynamics and aircraft structures, high speed electronic computers, radio and radar, including aerial design and radiation problems, engineering problems, and trials work requiring good practical outlook.—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting AS/54/A (April 14).

SOIL PHYSICIST (graduate who has received training in a recognized Soil Physics Laboratory, or with postgraduate experience in soil physics work, and preferably with experience in soil problems connected with irrigation) at the Sabi Valley Experimental Station, Department of Agriculture, Southern Rhodesia.—The Secretary, Rhodesia House, 439 Strand, London, W.C.2 (April 15).

ANALYST in the DEPARTMENT OF AGRICULTURE.—The Registrar, The University, Leeds 2 (April 10).

READER IN VETERINARY BIOCHEMISTRY at the Royal Veterinary College.—The Academic Registrar, University of London, Senate House, London, W.C.1 (April 20).

CHAIR OF CHEMISTRY in University College, Dundee.—The Secretary, University of St. Andrews, College Gate, St. Andrews (April 30).

LECTURER IN BIOCHEMISTRY—The Secretary, Queen's University, Belfast (April 30).

LECTURER (with degree in metallurgy, engineering or related science) in INDUSTRIAL METALLURGY.—The Registrar, The University, Edgbaston, Birmingham 15 (April 30).

PEDOLOGIST or ASSISTANT PEDOLOGIST (with a good degree in science or agriculture or equivalent, and ability to express ideas in written work) at the Soil Bureau, Department of Scientific and Industrial Research, New Zealand, for soil surveys in New Zealand, and possibly for short-term secondment in the Pacific Islands—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting 3/64/142 (April 30).

RESEARCH OFFICER (graduate in physics, mechanical engineering, physical chemistry, or chemical engineering, and preferably with some experience of research in the preservation, processing and transport of food, preferably fish) at the **FISHING INDUSTRY RESEARCH INSTITUTE**, Cape Town, South Africa—The Secretary, P.O. Box 1233, Cape Town, South Africa (April 30).

SENIOR LECTURER IN ADULT EDUCATION at the University of New England, Armidale, New South Wales, Australia, to organize and administer tutorial classes, discussion groups, and other general adult education activities in northern New South Wales as may be required by the Council of the University—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Armidale, April 30).

SENIOR LECTURER or LECTURER (university graduate, or chartered mechanical engineer, and with some years of industrial experience in a design office) in **MACHINE DESIGN**, in the Department of Mechanical Engineering, University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, April 30).

HIGHLY MISCELLANEOUS RESEARCH FELLOW IN AERONAUTICS, for post-graduate research into problems of vibration or stability and control of aircraft—The Warden, College of Aeronautics, Cranfield, Bletchley, Bucks (May 1).

CHAIR OF CHEMICAL PATHOLOGY in St. Mary's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 3).

CHAIR OF PHYSICAL CHEMISTRY tenable at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 5).

CHAIR OF PHYSIOLOGY tenable at Queen Elizabeth College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 6).

ASSISTANT BOTANIST (preferably with experience in microscopy, and with mathematical ability) in the **POMOLOGY SECTION** for work on plant anatomy—The Secretary, East Malling Research Station, near Maidstone, Kent (May 17).

PRISING SCHOLAR (preferably honours graduate, or final year undergraduate in engineering, mathematics or physics) in **AERONAUTICS**—The Warden, College of Aeronautics, Cranfield, Bletchley, Bucks (June 1).

DEMONSTRATOR IN ORGANIC CHEMISTRY and **DEMONSTRATORS IN INORGANIC CHEMISTRY**—The Registrar, The University, Nottingham. **LECTURER AND ASSISTANT PROFESSOR IN THE DEPARTMENT OF BACTERIOLOGY** at the Hebrew University of Jerusalem—Prof. Samson Wright, Middlesex Hospital, London, W.1.

LECTURER (with a university degree in agriculture, preferably with knowledge of tropical agriculture, and some teaching experience) in **AGRICULTURE**, at the College of Agriculture, Mauritius—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODB.63/52/06.

MASTER (with first-class honours degree, preferably Oxford or Cambridge) to **TEACH BIOLOGY** up to University Scholarship standard—The Headmaster, Haberdashers' Aske's Hampshire School, West-bere Road, London, N.W.2.

PHYSICIST (with a degree in physics, and capable of applying experimental techniques to the solution of fund problems in the iron and steel industry) in the **FLUID DYNAMICS SECTION** of the Physics Department in London—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

RESEARCH SCIENTIST (with B.Sc., preferably in physics) for research on domestic heating—The British Coal Utilization Research Association, Randaile Road, Leatherhead, Surrey, quoting A.2.

SCIENTIFIC OFFICER (with an honours degree in science, preferably physics, with postgraduate course, or equivalent experience in meteorology) at the **ROYAL OBSERVATORY**, Hong Kong, for forecasting, general meteorology, research, etc.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODB. 57/51/03.

SCIENTIFIC OFFICERS (with first- or second-class honours degree in chemistry or equivalent) and **EXPERIMENTAL OFFICERS** (with at least H.S.C. (science) or equivalent) to undertake research involving the study of various physical and electrical properties of solid inorganic chemical materials, and their behaviour in ceramic applications—The Administrative Officer, Recruitment, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 40/W.G.R.

Other Countries

Report on Federal Forest Administration in the Federation of Malaya, for the year 1952. By J. P. Edwards. Pp. 70+4 plates. (Kuala Lumpur: Government Printer, 1953.) 2 Malaysian dollars; 4s. 8d. [151]

Federation of Malaya. Annual Report of the Department of Agriculture for the year 1952. By O. J. Voelcker. Pp. viii+66. (Kuala Lumpur: Government Printer, 1953.) 2 Malaysian dollars; 4s. 8d. [151]

California Institute of Technology. Annual Report 1952-1953. Comprising the Reports of the President, the Secretary, the Comptroller, and Other Administrative Officers. Pp. v+142. (Pasadena, Calif.: California Institute of Technology, 1953.) [151]

Commonwealth of Australia. Department of Supply, Research and Development Branch. Annual Report of the Defence Standards Laboratories for the year ended 30th June, 1953. Pp. 56. (Melbourn, Vic., Alexandria, N.S.W., Finsbury, S.A.: Department of Supply, Research and Development Branch, 1953.) [151]

Commonwealth of Australia. Commonwealth Scientific and Industrial Research Organization. Fifth Annual Report, for the year ending 30th June, 1953. Pp. vi+230. (East Melbourne: Commonwealth Scientific and Industrial Research Organization, 1953.) [151]

Labo 53. (Handbook of Laboratory Apparatus, Scientific and Technical Instruments.) Pp. ii+464+viil. (Paris: O.P.F., 61 Rue de Malte, 1953.) [151]

Publications of the Yerkes Observatory. Vol. 8, Part 6: Measurements of Double Stars. By G. Van Biesbroeck. Pp. ii+224. (Chicago: University of Chicago Press; London: Cambridge University Press, 1954.) 10 dollars. [151]

Sveriges Geologiska Undersökning. Ser.Aa. No. 192: Beskrivning till Karthbladet Önsala. Av R. Sandegren och P. H. Lundegårdh. Pp. 100+1 plate. 10 kronor. Ser.Aa. No. 194: Beskrivning till Karthbladet Säter. Av S. Helmgvist och G. Lundqvist. Pp. 98+1 plate. 10 kronor. Ser.O. No. 518: Vissa Ammons Förekomst i Markon i Koppbergs Län. Av O. Arrhenius. Pp. 40. 2.50 kronor. Ser.O. No. 519: Fårlas Bricks. Av Carl-Gösta Wenner. Pp. 16+8 plates. 2 kronor. Ser.O. No. 520: Kvarter, Fålskap och Glimmer i Samt Förekomst i Dräva i Sverige. Av Nils Sundin. Pp. 22+2 plates. 10 kronor. Ser.O. No. 521: Låm Metasomatism och Metamorf Differentiation i den Adak Area. By Sven Gavelin. Pp. 52. 3.50 kronor. Ser.O. No. 522: Konglomerat på Bällingsberget i Nedertälje 6: N. Av Erik Ahman och Olof H. Ödman. Pp. 20+1 plate. 1.50 kronor. Ser.O. No. 524: Geology and Ores of the Kristineberg Deposit, Västernorrland, Sweden. By Torsten Du Rietz. Pp. 90+4 plates. 6.50 kronor. Ser.O. No. 525: Bergarterna i Delamöransens Block-Och Grusmaterial. Av Jan Lundqvist. Pp. 48. 2.50 kronor. Ser.O. No. 526: Non-Agnostic Trilobites of the Middle Cambrian of Sweden. III. By A. H. Westergård. Pp. 60 (8 plates). 4 kronor. Ser.O. No. 527: De Geologiska Resultaten från Borrmärgarna Vid Hölvik. Del V: The Macro-Fossils of the Upper Ordovician. By Hilmar Ödum. Pp. 38+4 plates. 3.50 kronor. (Stockholm: Kungl. Boktryckeriet. P. A. Norstedt och Soner, 1952 and 1953.) [151]

Sveriges Geologiska Undersökning. Ser.O. No. 528: Der Geologische Bau Des Sulitelma-Sakajaurgebietes in den Nordkandischen Kaledoniden. Von G. Kantaky. Pp. 229+9 plates. 15 kronor. Ser.O. No. 529: Vallen-Alhammaradets i Nedertälje 8: N. Av Erik Ahman. Pp. 22+1 plate. 2 kronor. Ser.O. No. 531: Petrology of the Mondal-Styrso-Valda Region in the Vicinity of Götterby. By H. Lundegårdh. Pp. 58+1 plate. 4 kronor. Ser.O. No. 532: Jordslut i Sverige, 1941-1950. Av K. B. Sahström. Pp. 34+1 plate. 3 kronor. Ser.Ad. No. 2: Beskrivning till Karthbladet Lund. Av Gunnar Hultström. Pp. 102+2 maps. 8 kronor. Årskattelse for År 1953. År 1950. Pp. 8. 0.50 kronor. Årskattelse for År 1953. Pp. 10. 0.50 kronor. (Stockholm: Kungl. Boktryckeriet. P. A. Norstedt och Soner, 1952 and 1953.) [151]

Survey of India. Technical Report, 1952. Part 2: Geodetic Work. Pp. x+90+22 charts. (Delhi: Survey of India, 1953.) 8 rupees; 16s. 6d. [151]

Commonwealth Scientific and Industrial Research Organization. Australia. Soil Publication No. 2: Pedology of Part of the Upper Hunter Valley, New South Wales. By R. Brewer and E. B. Baker. Pp. 104. **Soil Publication No. 3: The Soils of Part of the Southern Flinders Ranges, South Australia.** By G. Blackburn and R. M. Baker. Pp. 56+2 plates. **Bulletin No. 272: Standardized Plant Names: A Revised List of Standard Common Names for the More Important Australian Grasses, Other Pasture Plants, and Weeds.** Pp. 132. **Bulletin No. 273: The Definition and Prediction of the Optimal Harvest Time of Pea Canning Crops.** By L. J. Lynch and B. S. Mitchell. Pp. 44. (Melbourne: Commonwealth Scientific and Industrial Research Organization, 1953.) [151]

Smithsonian Miscellaneous Collections. Vol. 122, No. 8: Further Additions to the Birds of Panama and Colombia. By Alexander Wetmore. Pp. 12. (Publication 4142.) (Washington, D.C.: Smithsonian Institution, 1953.) [151]

Bulletin of the Central Building Research Institute, Roorkee. Vol. 1, No. 3: Corrugated Concrete Rhell Roofs. By Dr. Kurt Billig. Pp. 40+14 plates. (New Delhi: Council of Scientific and Industrial Research, 1953.) 1 rupee, 8 annas. [151]

Göteborgs Kungl. Vetenskaps- och Vitterhets-Samhälles Handlingar. 81ste Följden. Ser.B. Band 6, No. 9: Acidmetrisk Carbonate Analys. Av Stina Gripberg. Pp. 22. (Göteborg: Mångens Boktryckeri Aktiebolag, 1953.) [151]

Annual Report of the Kodakikanal Observatory for the Year 1951. Pp. 10. 1 rupee; 1s. 6d. **Annual Report of the Kodakikanal Observatory for the Year 1952.** Pp. 12. 13 annas; 1s. (Delhi: Manager of Publications.) [151]

Kodakikanal Observatory. Bulletin No. 122. Part 1: Summary of Prominence Observations for the First Half of 1950. Pp. 40. 7 rupees, 8 annas; 12s. 6d. **Bulletin No. 123: A Note on the Observations of Sunspots Recorded at Kodakikanal from 1903 to 1950.** By N. Ananthakrishnan. Pp. 12. 1 rupee, 8 annas; 2s. 2d. **Bulletin No. 124. Part 1: Summary of Prominence Observations for the Second Half of 1950.** Pp. 50-102. 3 rupees, 3 annas; 5s. 6d. (Delhi: Manager of Publications, 1953.) [151]

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

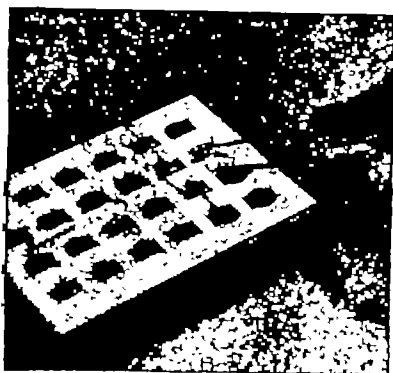
Great Britain and Ireland

General Post Office. Second Report of the Television Advisory Committee, 1952. Pp. 26. (London: H.M. Stationery Office, 1954.) 1s. net. [191]

Ministry of Agriculture and Fisheries. Fishery Investigations. Series 1, Vol. 6, No. 7. Part 1: The Soles of Beach; Part 2: Age and Growth of the Trout (*Salmo trutta*), Grayling (*Thymallus thymallus*) and Perch (*Perca fluviatilis*), and Roach (*Rutilus rutilus*), of Llyn Tegid (Bala) and the Roach of the River Brink. By Dr. J. W. Jones. Pp. 18. (London: H.M. Stationery Office, 1953.) 2s. net. [201]

General Register Office. Census 1951, England and Wales. County Report: Middlesex. Pp. xvi+70. (London: H.M. Stationery Office, 1954.) 20s. net. [201]

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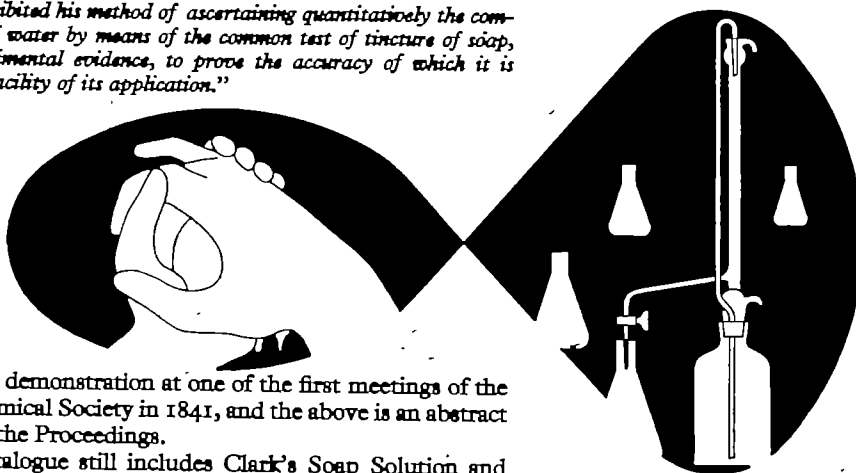
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SIR JOHN CASS COLLEGE

JEWRY STREET, LONDON, E.C.3

Telephone No.: ROYAL 3383

The College prepares students by full-time and by part-time day and evening courses in Botany, Mathematics, Chemistry, Physics, Geology, and Zoology for the Intermediate Examination and the B.Sc. General Degree of the University of London for internal and external students and for professional examinations. Full-time and part-time courses are also held for the B.Sc. Internal Special Degrees in Mathematics and in Physics, and for the B.Sc.(Eng.) Metallurgy Degree. There are full-time courses for the London Internal Special Degree in Chemistry and for the External Special Degrees in Botany and in Zoology. Facilities are provided for research and post-graduate study, and short courses of lectures are held on a variety of special topics.

Applications for enrolment for the academic year, 1954-55, may now be made on forms to be obtained from the Secretary.

ROYAL TECHNICAL COLLEGE

SALFORD

Principal: P. F. R. Venables, B.Sc., Ph.D., F.R.I.C.

DEPARTMENT OF PURE AND APPLIED PHYSICS

A short postgraduate course on Semi-conductors will be held on Friday, May 21, and Saturday, May 22, 1954. Lecturers: Professor F. A. Vick, O.B.E., Ph.D., F.Inst.P., H. J. Clark, B.A., J. A. F. Cormack, B.A., A.Inst.P., W. Needham, M.Sc., M.I.B.E., F.Inst.P., H. V. Shumner, M.Sc., Ph.D., D. D. Jones, M.Sc., D.I.C., D. A. Wright, M.Sc., F.R.A.S., F.Inst.P. Fee for the course, £1 10s 6d.

Forms of application, giving brief details of the lectures, may be obtained from the Head of Department, W. G. Darvell, M.Sc., F.Inst.P., Royal Technical College, Salford.

H. H. TOMSON,

Clerk to the Governors

OFFICIAL APPOINTMENTS

The engagement of persons answering these advertisements must be made through a Local Office of the Ministry of Labour or a Scheduled Employment Agency if the applicant is a man aged 18 to 64 inclusive, or a woman aged 18 to 59 inclusive, unless he or she, or the employment, is exempted from the provisions of the Notification of Vacancies Order, 1952.

SABI VALLEY EXPERIMENTAL STATION

DEPARTMENT OF AGRICULTURE

SOUTHERN RHODESIA

SOIL PHYSICIST

Applicants, under 36, must be graduates who have received training in a recognized soil physics laboratory or who have had postgraduate experience in soil physics work. Experience of soil problems connected with irrigation advantageous, but not essential. Starting Salary Scale: £624 by £90 to £904 by £45 to £1,074 by £120 to £1,194 by £48 to £1,482 per annum. Actual starting point, up to £984 per annum, depends on academic qualifications and experience. Allowances: Marriage £50 per annum, children's £60 per annum first, £24 per annum each other dependent child. Accommodation: A house will be available at reasonable rental.

Application forms and further details from the Secretary, Rhodesia House, 429 Strand, London, W.C.2. Completed forms to be returned by April 15, 1954.

BIRKENHEAD EDUCATION COMMITTEE

BIRKENHEAD TECHNICAL COLLEGE

Applications are invited for the following additional appointments to the full-time teaching staff: Science: (a) Lecturer in Organic Chemistry; (b) Lecturer in Physical and Inorganic Chemistry; (c) Assistant (Grade B) in Physics; (d) Assistant (Grade B) in Biology; (e) Assistant (Grade B) in Chemistry.

Further details and form of application can be obtained on receipt of stamped, addressed envelope (stating post) from the undersigned, to whom completed applications should be returned not later than April 2, 1954.

H. GLYN WILKINSON,

Director of Education.

Education Offices,
63 Hamilton Square,
Birkenhead

SHORT SERVICE COMMISSIONS IN THE INSTRUCTOR BRANCH OF THE ROYAL NAVY

Applications are invited from university graduates and qualified teachers under 36 years of age for short service commissions of three, four or five years in the Instructor Branch, Royal Navy. Applications will also be accepted from final year undergraduates, and these will be considered in anticipation of their degree results. Requirements are mainly for officers with qualifications in mathematics, science (physics, chemistry, metallurgy) or engineering, but a few vacancies exist for officers with qualifications in history or English, with a sound mathematics or science background. After two years' service, officers will be eligible for selection for permanent commissions. A short service engagement in the Instructor Branch will discharge any candidate's obligation under the National Service Act. Entry will be in two grades. Selected candidates with first- or second-class honours degrees receive approximately £410 in their first year's service, £429 in second year, £548 in third and fourth years, £584 in fifth year. Other candidates receive £319 in first, £392 in second and third years, £429 in fourth and fifth years. Previous officer service will be recognized for adjustment of seniority and rate of pay on entry. Accommodation and rations are provided or allowances in lieu. Married officers, if aged 25 or over, receive marriage allowance of £338 per annum if not accommodated in official married quarters, £283 per annum if they are so accommodated. Married officers under the age of 25 receive marriage allowance of £146 per annum, but are not entitled to be accommodated in official married quarters. An initial outfit allowance of £115 is paid, together with a free issue of certain articles of clothing. A reduced allowance is payable to candidates with previous Naval Service as officers. Tax-free gratuities of £300, £400 or £500 are payable at the end of three, four or five years respectively. Instructor officers serve both ashore and afloat, and their duties include both technical instruction and general education. Officers with suitable qualifications may also be trained and appointed for full- or part-time meteorological and weather forecasting duties. Service in the Instructor Branch will, in the case of officers who enter from a contributory service under the Teachers' (Superannuation) Act, be treated as contributory service, contributions being deducted from the above gratuities. Other officers may have their service in the Instructor Branch similarly treated if they so desire.

Fuller details and application forms may be obtained from Director (P), Naval Education Service, Admiralty, London, S.W.1. Completed application forms should be returned, if possible, before May 31, 1954.

H.M. COLONIAL SERVICE

Applications are invited for the following post: West African Fisheries Research Institute, Sierra Leone. A vacancy exists for a Biochemist. Candidates must be male and possess at least a good second-class honours degree, with appropriate postgraduate experience. Appointment either on probation in the Colonial Research Service with superannuation under contributory superannuation scheme, or on temporary terms with eventual gratuity of 15 per cent of salary. Salary in Scientific Officer scale (£400 to £650 per annum), plus overseas research allowance of £145 to £175 per annum. Cost-of-living allowance at present 27½ per cent of first £200 of basic salary, 25 per cent of next £400 and 12½ per cent of remainder (maximum £200 per annum), also payable. Outfit allowance £60 on first appointment. Free passages on appointment and leave for officer, wife and children under 13 years of age. Government quarters, when available, at rental of up to 10 per cent of basic salary (maximum £150 per annum).

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference number CDE 197/194/01.

UNIVERSITY OF GLASGOW

LECTURESHIP IN AGRICULTURAL BOTANY

Applications are invited for a Lectureship in Agricultural Botany. Salary scale £600 to £1,100 Initial salary according to experience and qualifications. F.S.S.U. and family allowance benefits.

Applications (eight copies), should be lodged not later than March 31, 1954, with the undersigned, from whom further particulars may be obtained.

RBT. T. HUTCHESON,

Secretary of University Court

BRITISH COTTON INDUSTRY RESEARCH ASSOCIATION

There are the following vacancies at the Shirley

Institute for research chemists who are honours graduates or graduates with higher degrees: 1. An Organic Chemist, for fundamental research on the chemistry of cellulose and its derivatives. 2. A Chemist, with a leaning towards physical and/or analytical chemistry, for fundamental research in cellulose chemistry. 3. A Physical Chemist, to study the degree of polymerization of macromolecular substances, with ultracentrifuge, etc. 4. A Chemist (or Physicist), with a knowledge of X-ray crystallography, for research on the structure of textile fibres. 5. A Chemist, with experience in infra-red spectroscopic techniques, for research on the structure of textile fibres and on the mechanism of dyeing. 6. A Chemist, for fundamental and technical research on the bleaching of textiles. 7. A Chemist, for fundamental and technical research on the chemical finishing of textiles. The minimum qualification for these posts is a second-class honours degree, and applications are invited from those doing National Service, from students taking degrees in 1954 and from people who expect to be available before the end of 1954. The starting salary for men and women who have just graduated will be £500 to £550 per annum, and up to £750 will be paid to those with research experience, a higher degree, or both. Some of the posts may be filled by more senior men, to whom starting salaries of up to £900 will be paid. All posts carry superannuation benefits under the Federated Superannuation System for Universities. Experience of textiles is not essential for any of these positions. 8. There is also a vacancy for a man to carry out investigations in textile finishing, the work being primarily concerned with increasing productivity in this section of the industry. Applicants should have a first- or second-class honours science degree and postgraduate experience, preferably of textile bleaching, dyeing and finishing processes. Starting salary for this post will be up to £900 per annum, and the post qualifies for participation in the Federated Superannuation System for Universities.

Application for all these posts, giving full particulars of qualifications and career, should be sent to Dr. F. C. Toy, Director of Research, Shirley Institute, Didsbury, Manchester, 20.

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF SUPPLY
HIGH SPEED AERODYNAMICS
LABORATORY

SALISBURY, SOUTH AUSTRALIA

Applications are invited for the position of Principal Scientific Officer (Supersonic Theory) with a salary range of £A.1,688 minimum to £A.1,874 maximum with the above Establishment. Duties: To initiate and be responsible for research, especially of a mathematical nature, in supersonic and transonic flow; and to exercise supervision over the work of other scientific staff and of a small computing "pool". Qualifications: Degree of high standard in mathematics, or equivalent qualifications, extensive experience of theoretical work in supersonic aerodynamics and ability to direct the work of others. Where permanent appointment is accepted, the successful candidate will be eligible to become a contributor to the Commonwealth Superannuation Scheme. Under specified conditions, first-class boat fare (if first-class berth available) of the appointee and his dependants (wife and dependent children) will be paid by the Commonwealth. There is difficulty in obtaining unfurnished accommodation in the Adelaide area, but the Department is prepared to help suitable applicants with this problem. While no definite assurances can be given, intending candidate should not let the housing problem deter them in making their initial application.

Applications to Senior Representative (A.P.10) Department of Supply, Australia House, The Strand, London, W.C.2, by April 5, 1954.

ST. THOMAS'S HOSPITAL

MEDICAL SCHOOL
(UNIVERSITY OF LONDON)

LONDON, S.E.1

Applications are invited for the post of Lecturer in the Sherrington School of Physiology. Appointment to start as soon as can be arranged and not later than October 1, 1954. Candidate must be medically qualified. Salary £800 to £1,100, according to qualifications and experience with superannuation and family allowance.

Applications, in triplicate, with the names of three referees, should be addressed to the Dean of the Medical School, and should be received not later than April 14, 1954.

SUGAR MANUFACTURERS' ASSOCIATION (OF JAMAICA), LTD.

Vacancies exist for three Senior Research Officers, to take charge of sugar cane research in the main ecological divisions of the sugar area. They are expected to study and know the conditions affecting sugar cane production in their respective divisions, with particular reference to soil/plant relationships (including nutrition, moisture and ripeness), soil management, chemical weed control, variety trials and disease and other surveys. Although much of the work is planned and co-ordinated centrally, officers should have initiative and the ability to formulate and develop their own complementary investigations. They will be posted to districts in accordance with their specialized knowledge and experience, and the nature of the dominant problems of districts. Applicants should preferably have had specialized postgraduate training in a branch of science applied to agriculture—e.g., plant physiology, soils, crop husbandry, or agricultural engineering. Appointments will be for a period of three years in the first instance. Selected candidates will be provided with free passages to Jamaica and required to assume duty not later than November 1, 1954. Leave with passages is granted after three-year service periods, and there is a contributory pension scheme. Salary will be in accordance with qualifications and experience.

Further particulars may be obtained from the Director of Research, Sugar Research Department, Mandeville, Jamaica, B.W.I., to whom applications, with full personal particulars, and three references, should be addressed to reach him as early as possible and before May 7, 1954.

RESEARCH FELLOWSHIPS IN GOVERNMENT SCIENTIFIC ESTABLISHMENTS

The Civil Service Commissioners invite applications for a number of Senior and Junior Research Fellowships, tenable for three years at Government Scientific Establishments, for research into subjects of importance to H.M. Government. There are no age limits, but candidates must have either a first- or second-class honours degree in an appropriate subject, and must be able to show evidence of a very high standard of ability in research. At least two years' postgraduate experience will be expected of candidates for Junior Fellowships, and at least three years' of candidates for Senior Fellowships. Remuneration will be according to individual merit and experience, at rates between £800 and £1,000 for Senior Fellowships, and between £500 and £700 for Junior Fellowships. F.S.S.U. scheme applies. The field of research in which Fellowships may be awarded if candidates of the requisite high quality present themselves cover a very wide range, and Fellowships may be tenable at any of a considerable number of scientific establishments.

Further information and application forms from Civil Service Commissioners, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1., quoting S.4300/54. Application forms to be returned by April 30, 1954.

UNIVERSITY OF NATAL SOUTH AFRICA

Applications from suitably qualified persons are invited for the following posts in the Department of Physics at the University: (a) Senior Lecturer at Pietermaritzburg, salary scale £1,050 by £50 to £1,400 per annum. (b) Two Lecturers, one at Pietermaritzburg and one at Durban, salary scale £800 by £50 to £1,050 per annum. Cost-of-living allowances at the rate of £234 per annum is payable in the case of married officers.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1. The closing date for the receipt of applications, in South Africa and London, is April 7, 1954.

THE LONDON HOSPITAL, WHITECHAPEL, E.1., has vacancy for Research Assistant in the Department of Neurology and Psychiatry. The major part of the work will be concerned with the development of E.E.G. equipment and techniques, including the taking of corticograms during neurosurgical operations. Applicants will require a good knowledge of electronic engineering and of the electro-physiology of the nervous system. Salary dependent on qualifications and experience.—Applications, giving names of two referees, should be received by the Secretary before March 27, 1954.

MONMOUTHSHIRE EDUCATION COMMITTEE

TECHNICAL COLLEGE OF MONMOUTHSHIRE, CRUMLIN

A Laboratory Technician, to take up duties on May 1, 1954, or as soon as possible after that date, is required at the above College. Candidates must have had experience as a Laboratory Assistant or Steward, and should have a good practical knowledge of one or more of the following crafts, viz.: scientific glass-blowing; carpentry; photographic processing; instrument or apparatus repair; or preparation of metallurgical specimens. Candidates should hold an appropriate ordinary national certificate or City of Guilds certificate. Salary £400 by £20 by £15 by £15 to £450 per annum.

Forms of application obtainable from the undersigned, to be returned not later than March 31, 1954.

C. B. GITTINS,
Director of Education.

County Hall,
Newport, Mon.

CITY OF CARDIFF EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY AND COMMERCE

Principal: Dr. A. Harvey

Applications are invited for the post of Assistant Lecturer, Grade "B," in the Department of Applied Physics and Electrical Engineering. Candidates should have a good honours degree in physics or electrical engineering. Some research, industrial or teaching experience is essential. The present salary scale for an Assistant Lecturer, Grade "B," is £490 by £25 to £765 per annum, plus appropriate allowances for training and degree. Applicants with suitable professional or industrial experience (over the age of 21) may be started higher up the scale at the rate of one increment of £18 for each year of such experience.

Forms of application, together with further particulars, may be obtained from the undersigned, to whom they should be returned as soon as possible.

ROBERT E. PRESSWOOD,
Director of Education.

City Hall,
Cardiff.

NORTHERN REGIONAL HOSPITAL BOARD (SCOTLAND)

Applications are invited from science graduates for a post of non-medical Biochemist in the Board's Laboratory Service. The main duties are at Craig Dunan Hospital, Inverness, with opportunity for biochemical investigations into mental illness. The post is in the basic grade, and the salary scale for candidates who have completed the probationary period is £385 by £30 to £765 per annum.

Further particulars and application forms are obtainable from the undersigned, with whom applications should be lodged by March 31, 1954.

A. M. FRASER, M.D.,
Secretary and Administrative
Medical Officer.

Office of the Northern Regional Hospital Board,
Raigmore, Inverness.

MINISTRY OF SUPPLY, R.A.R. ROCKET

Propulsion Department, Westcott, Bucks, requires: Scientific Officers (Ref. A.59/54A). (1) Mechanical Engineer, for work on liquid motors in project group. (2) Physicist or Physical Chemist, with mathematical skill, for internal ballistics section. (3) Physicist or Mathematician, for fundamental work on nozzle design and related problems in gas dynamics (heat transfer) section.

Qualifications, first- or second-class honours degree, or equivalent, in appropriate subject. Salaries within range £417 to £781. F.S.S.U. benefits may be available. Experimental Officer Class (Ref. A.60/54A). (1) Physicist or Engineer, for work on solid motors in development and project sections. Design experience useful. (2) Engineer, for experimental and theoretical work on development of components for liquid propellant rocket motors. Qualifications, higher school certificate (science), or equivalent, though further training in physics or engineering to H.N.C. or degree standard may be an advantage. Salaries within range, Experimental Officer (minimum age 26) £549 to £799, or Assistant Experimental Officer £254 (age 18) to £576. All posts unestablished. Women's rates somewhat less.—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting appropriate reference. Closing date April 3, 1954.

UNIVERSITY OF BIRMINGHAM DEPARTMENT OF ENGINEERING PRODUCTION

(1) Lectureship (Grade II) in Applied Statistics to date from July 1, 1954. Scale salary £530 to £1,100. Candidates should give details of academic qualifications and industrial experience, which should preferably be in production study or operational research field. (2) Tube Investments Research Fellowship, to date from June 1, 1954, or as soon as possible thereafter. Candidates should give details of their career and of their academic qualifications, and must also state the particular lines of research which they are desirous of pursuing within the field of engineering production and industrial management. The Fellowship is normally awarded for two to three years, subject to review each year, and carries a salary of £1,000 to £1,500 per annum, according to qualifications.

Applications (in triplicate) for the two appointments should reach the Registrar, The University, Edgbaston, Birmingham, 15, by April 30, 1954.

C. G. BURTON,
Secretary

The University,
Birmingham, 3.

UNIVERSITY OF BELFAST

The Senate of the Queen's University of Belfast invite applications for a Lectureship in Biochemistry from October 1, 1954. Salary range £550 by £50 to £850, and on certain conditions being fulfilled to £1,150, plus contributory pension rights under the F.S.S.U. Initial placing on the scale £550 to £850 is dependent on experience and qualifications. Applications should be received by April 30, 1954.

Further particulars may be obtained from G. R. Cowie, M.A., LL.B., Secretary.

ATOMIC ENERGY RESEARCH ESTABLISHMENT

Harwell, Berkshire, requires a Scientific Officer or Senior Scientific Officer for development work on carbon for nuclear reactors, involving structural studies of porous solids. Candidates should hold a first- or second-class honours degree, or equivalent qualification, in physics, chemistry or metallurgy. Some experience with carbon or in the ceramic field would be valuable, but is not essential. Salary according to qualifications and experience within the scales: Scientific Officer, £420 to £780; Senior Scientific Officer, £575 to £1,030.—Applications, quoting 2/103/70, giving full personal details, to the Establishment Officer, A.E.R.E., within two weeks.

MINISTRY OF SUPPLY RESEARCH AND DEVELOPMENT ESTABLISHMENTS

require Physicists with sound basic training, prepared to apply their knowledge to problems from many fields, including aerodynamics and aircraft structures, aircraft instruments, armaments, electronic circuits, radio and radar. Duties mainly experimental; may include trials work. Posts graded, according to qualifications and experience, in Scientific Officer class (requiring first- or second-class honours degree, or equivalent) or Experimental Officer class (requiring higher school certificate (science), or equivalent; pass degree may be an advantage). Salaries within ranges, Scientific Officer, £417 to £781; Experimental Officer (minimum age 26), £549 to £799; Assistant Experimental Officer, £254 (age 18) to £576. Women somewhat less. Appointments unestablished. F.S.S.U. benefits may be available for Scientific Officer class.—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.1/54A. Closing date April 14, 1954.

NATIONAL COAL BOARD INVITE APPLICATIONS

for a supernumerary appointment as Scientist in the Field Investigation Group of their Scientific Department. Applicants should have a first- or good second-class honours degree (or equivalent) in physics, engineering, mathematics or statistics, and should, in addition, have several years' industrial or laboratory research experience. Experience in operational research would be an advantage. The successful candidate will be based in London, but will be required to lead a team carrying out field work at collieries. Appointment will be in the grade of Scientist either Grade II (£645 by £30 to £1,095 scale) or Grade III (£445 by £25 to £845 scale), salary being dependent on qualifications and experience. London location allowance is payable in addition.—Write, giving full particulars (in chronological order) of age, education, qualifications and experience (with dates), to National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, marking envelope TT/750. Original testimonials should not be forwarded. Closing date April 3, 1954.

H.M. COLONIAL SERVICE KENYA

Vacancies exist for (1) a Factory Inspector and (2) a Factory Inspector (Engineering) in the Labour Department of Kenya. For (1) candidates should possess a University degree in engineering or comparable professional qualifications (e.g., A.M.I.Mech.E.) and must have had experience of factory inspection or of a safety officer's work in a large industrial concern. Candidates lacking professional qualifications may however be considered if they offer exceptionally wide works or other special practical experience. For (2) a University degree or comparable technical qualification and a first-class Ministry of Transport Certificate (Steam) are required, but candidates who appear to be exceptionally well fitted by reason of extensive practical experience in the inspection of steam boilers and other pressure vessels, will be considered. Duties are similar to those carried out under United Kingdom factory laws. Appointments permanent and pensionable subject to probationary period. Salary scale £550 to £1,320, with initial salary dependent upon qualifications and experience. A non-pensionable cost-of-living allowance of 35 per cent of salary (maximum £350) also payable. Outfit allowance. Free passages for officer and family up to cost of three adult passages in all. Government quarters provided or allowance in lieu. Tour of service 40 to 48 months. Generous home leave. Free medical attention. Income tax at low local rates.

Further particulars and application form obtainable from the Director of Recruitment (Colonial Service), Colonial Office, Great Smith Street, London, S.W.1, quoting reference CDE 132/7/01/C1. Closing date for receipt of initial enquiries April 3, 1954.

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF SUPPLY AERONAUTICAL RESEARCH LABORATORIES

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Application forms obtainable from Senior Representative (AP11), Department of Supply, Australia House, The Strand, London, W.C.2, with whom applications close by April 5, 1954.

MATHEMATICIAN REQUIRED BY MINISTRY OF Supply Guided Weapons Establishment, Aberporth, South Wales, to undertake responsibility for film reading and computation section, including interpretation of records, and investigation of new and modified analysis techniques. Qualifications: minimum of higher school certificate (science), or equivalent. Experience in computing section and some knowledge of instrumentation equipment and techniques desirable. Salary within range, Experimental Officer (minimum age 26) £649 to £799. Women somewhat less. Appointment unestablished. Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A58/54A. Closing date April 3, 1954.

BRITISH ELECTRICITY AUTHORITY. RE-placement of Scientific and Industrial Research, Forest Products Research Laboratory, Princes Risborough, Bucks, in the grade of Scientific Officer (unestablished), for investigations on timber strength, wood sawing and machining. First- or second-class honours engineering degree (civil or mechanical), training in the work when in post, knowledge of timber technology not essential. Minimum age 21. Inclusive annual remuneration for a 45½-hour week: £430 to £904 (men), £430 to £696 (women). Prospect of permanent pensionable post for candidates under 28—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting Ref. C 99/53A. Closing date April 3, 1954.

PUBLIC SERVICE OF SOUTH AUSTRALIA

Applications will be received by the Public Service Commissioner, 31 Flinders Street, Adelaide, for the undermentioned positions until and including Friday, April 30, 1954. Applicants resident in England should forward their applications through the Secretary, Agent General for South Australia, who will also be available to answer any inquiries. Applicants should state full names, address, date of birth, marital status, academic qualifications, practical experience, and particulars of war service (if any). Copies of testimonials should be submitted with the application. Salaries quoted are actual and include cost-of-living adjustments to date.

Agricultural College Department—Senior Lecturer in Animal Husbandry. Salary Range: £A1,242 to £A1,347 or £A1,312 to £A1,417 per annum, according to qualifications and experience of appointee. Qualifications: A degree in science, veterinary science or agriculture, with some training in physiology and postgraduate experience. The successful applicant will be required to administer all phases of animal husbandry at the College, including the direction of policy in the various livestock branches and lecturing both to diploma and university students in selected phases of animal husbandry. The appointee will be expected to develop his own line of investigation. Considerable field and laboratory facilities are available. A house will be available for a married man at a rental to be fixed. **Museum Department—Entomologist.** Salary Range: £A1,117 to £A1,207 per annum. Qualifications: Applicants should have experience in the curating of insect collections (the South Australian Museum collection is unusually large, comprising upwards of two million specimens), and the ability to carry out entomological taxonomic research. Preference will be given to an applicant with a B.Sc. degree.

UNIVERSITY OF ST. ANDREWS

The University Court of the University of St. Andrews invites applications for appointment to the Chair of Chemistry in University College, Dundee. Candidates will be required to have special qualifications in inorganic or physical chemistry. The salary attached to this appointment is £1,900 per annum, together with F.S.S.U. benefits. The University operates a scheme of family allowances and a grant towards expenses of removal may be made. Candidates will be expected to take up duty, if possible, by about the beginning of September, 1954.

Further particulars may be obtained from the undersigned, with whom six copies of the application, together with the names of three referees, should be submitted not later than April 30, 1954.

DAVID J. B. RITCHIE,

Secretary of the University.

College Gate,
St. Andrews.

FACULTY OF MATHEMATICS

UNIVERSITY OF CAMBRIDGE

The Appointments Committee of the Faculty of Mathematics give notice that they intend to appoint from October 1, 1954, one or more University Lecturers and one or more University Assistant Lecturers. The appointments will be subject to the Statutes and Ordinances of the University. The stipend of a University Lecturer rises from £750 per annum to £1,250 per annum by annual increments of £50. The initial stipend of a University Assistant Lecturer is £600 per annum. Family allowances are payable.

Candidates should send their applications, with the names of two referees, to the Secretary of the Faculty of Mathematics, The Arts School, Bene't Street, Cambridge, so as to reach him by April 20, 1954.

ATOMIC ENERGY RESEARCH ESTABLISHMENT, Harwell, Berkshire, requires Experimental or Assistant Experimental Officers, for development work on carbon for nuclear reactors. One post involves high temperature work and the use of semi-technical scale equipment, and would suit candidate with engineering interests, particularly electrical. A second post is concerned mainly with laboratory examination and offers scope for a young physicist. Minimum qualification higher school certificate (science), or equivalent, but a degree in appropriate subjects would be advantageous. Minimum age 26 for Experimental Officer, 18 for Assistant Experimental Officer. Salary, according to qualifications and experience, within the scales: Experimental Officer, £650 to £800; Assistant Experimental Officer, £264 (at 18) to £580.—Applications, quoting 2/103/71, and giving full personal details, to the Establishment Officer, A.E.R.E., within two weeks.

McMASTER UNIVERSITY DEPARTMENT OF PHYSICS GRADUATE ASSISTANTSHIPS

Applications are invited for part-time teaching and research assistantships in the Department of Physics, McMaster University, from persons qualified to register in courses leading to the M.Sc. and Ph.D. degrees. Assistantships normally carry a yearly stipend of \$1,600 to \$1,850. Assistants are required to devote 10 to 12 hours per week during the academic season (October to April inclusive) and are able to devote full-time their research during the summer. Research is progress in the following fields: Theory; Molecular Spectra, F. R. Britton; Atomic Mass Determinations, H. E. Duckworth; Cosmic Rays, F. Gulber; Beta and Gamma Spectroscopy, M. V. Johns; Microwave Diffraction, A. B. McLean; Theoretical Nuclear Physics, M. A. Preston; Fusion Yields and Isotopic Abundances, H. G. Thode.

Interested persons should write to Dr. H. E. Duckworth, Department of Physics, Hamilton College, McMaster University, Hamilton, Ontario, Canada.

THE BRITISH RAYON RESEARCH ASSOCIATION

A number of Physicists are required to work on textile problems. Candidates should possess a good honours degree with some experience or training in research, not necessarily in textile research. Salaries will be in accordance with age and experience, and superannuation will be payable under F.S.S.U.—Applications to the Secretary, British Rayon Research Association, Barton Dock Road, Urmoston, near Manchester.

TECHNICIAN (PATHOLOGICAL) Required, for work in the new University Surgical Research Laboratories at the Queen Elizabeth Hospital, Birmingham. Candidates must have experience of histological methods, and the mounting of specimens, and a knowledge of any other skill, such as photography or metal work would be useful. Salary on University Scale (Grade C), according to age and experience.—Applications should be sent to the Professor of Surgery, Queen Elizabeth Hospital, Birmingham, 15, not later than March 31, 1954. Names of two referees to be given.

FARNBOROUGH, HANTS, ROYAL Aircraft Establishment Technical College (selective, day) requires Lecturer in Aircraft Structures, to teach subject to final B.Sc. and H.N.C. standard. Facilities for research may be available. Qualifications: good university degree, or equivalent, with considerable teaching and industrial or research experience. Salary on Burnham Technical scale, £900 by £25 to £1,000, plus £40 special addition and subject to Teachers' Superannuation Act. Housing accommodation to rent may be available to married man—Details and forms from Principal, to whom completed forms must be returned within fourteen days of this notice.

MATHEMATICIANS REQUIRED BY MINISTRY OF Supply Research and Development Establishments, mainly in Southern England. Wide scope of work, including research into aerodynamics and aircraft structures, high speed electronic computers, radio and radar, including aerial design and radiation problems, engineering problems, and trials work requiring good practical outlook. Appointments, according to qualifications and experience, as Scientific Officer (first or second-class honours degree in mathematics) £417 to £781; Assistant Experimental Officer (higher school certificate (science), or equivalent pass degree, including mathematics, may be at advantage), £264 (age 18) to £576; Experimental Officer (H.S.C., etc., but minimum age 26, with suitable experience), £649 to £799. Women somewhat less. Appointments unestablished F.S.S.U. benefits may be available for Scientific Officer class—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London S.W.1, quoting A.2/54/A. Closing date April 14, 1954.

BRITISH ELECTRICITY AUTHORITY, RE-search Laboratories, Leatherhead, require a Junior Engineer for testing, development and research work in the laboratories and in the field, in connection with the generation of electricity. Candidates should have a H.N.C., or equivalent, qualification in electrical or need actual engineering or in physics. Salary N.I.L. Grade 6, £390 to £696.—Forms from D. Moff, Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, to be returned by March 29, 1954. Quote reference N/461.

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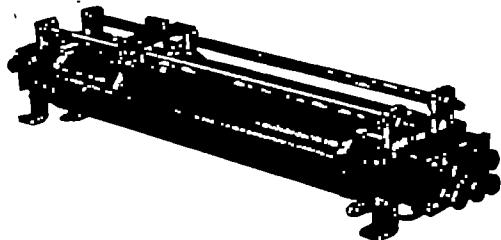
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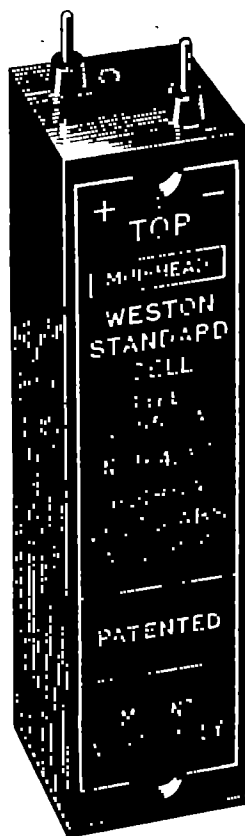
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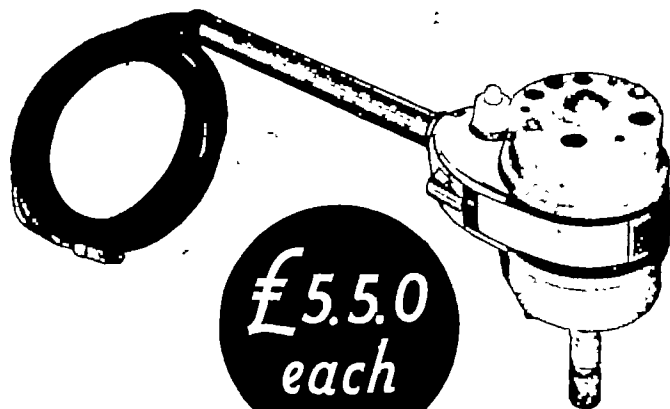
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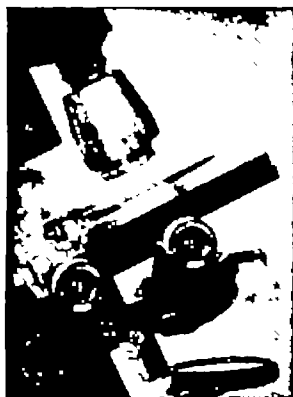


Vol. 173, No. 4404

SATURDAY, MARCH 27, 1954

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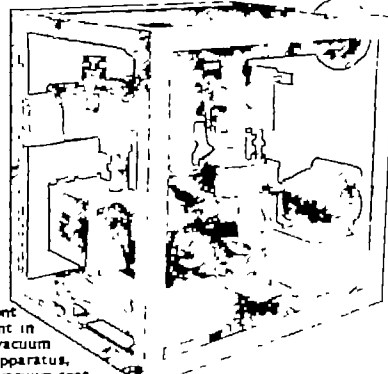
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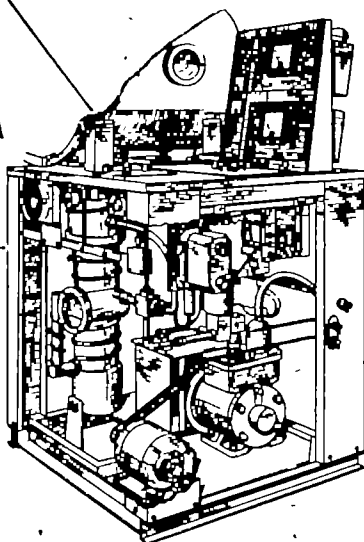
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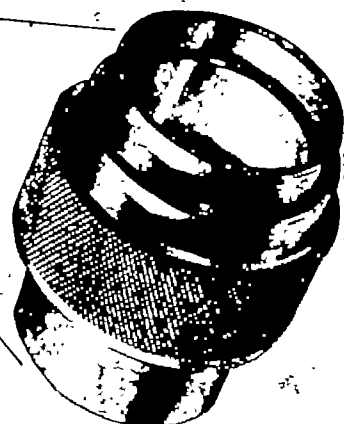
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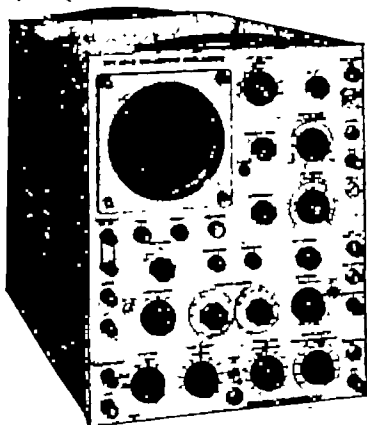
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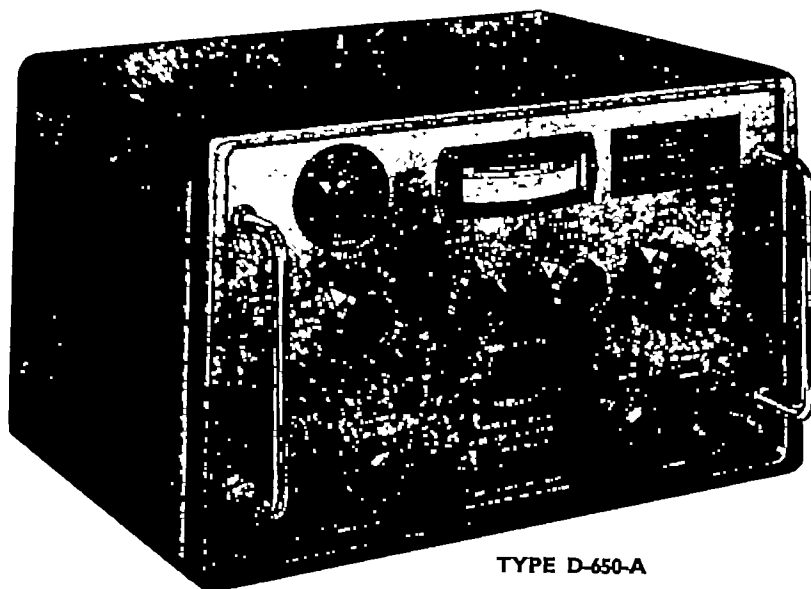
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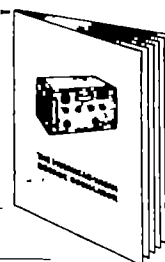
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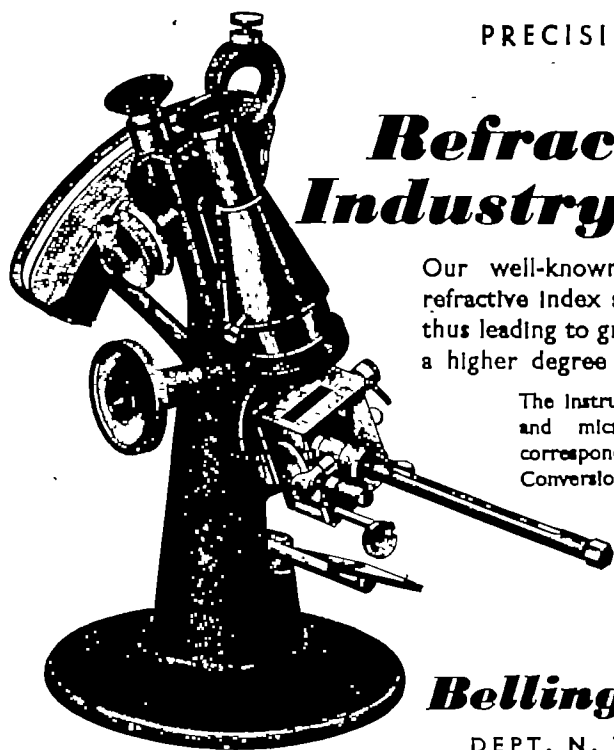
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(Readers may recall Dr. Tomkeieff's contribution on this subject published in Nature on 27 February, 1954, p. 393 et seq.)

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NATURE

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ACADEMIC FREEDOM: ITS WORLD-WIDE SIGNIFICANCE

AT the seventh Quinquennial Congress of Universities of the British Commonwealth at Cambridge last July, which opened with a discussion on the relations which should exist between governments and universities, and at the International Congress on Science and Freedom held at Hamburg later the same month, warm tributes were paid to the University Grants Committee as a model for the distribution of government subsidies to universities. However, Dr. H. W. Dodds, president of Princeton University, indicated that the device is unsuitable for the universities of the United States, where its introduction would almost certainly expose the universities to undesirable pressures which are not experienced in Great Britain. He is of opinion that political, psychological and constitutional reasons make it unlikely that grants could be made unconditionally in the United States.

On the other hand, Dr. E. G. Malherbe, principal and vice-chancellor of the University of Natal, warmly advocated the application of this device to the finance of the South African universities, and it appears from the report of the Holloway Commission, tabled in Cape Town last summer, that this is likely to be done. The Commission was appointed in August 1951 as a result of widespread dissatisfaction with existing university salaries and with the present rigid and inelastic State subsidization, which had, in fact, broken down. The Commission holds that to enable the universities to fulfil their functions they require not only more money, with safeguards to the State against unrestricted financial obligations, but also greater freedom. The idea of attaching strings to the subsidies by regulations for State control was rejected by the Commission, which suggested an independent University Grants Committee, mainly to administer specially voted funds for research, but also to inspect the work of the universities, to watch over their development and to advise the Minister of Education on their financial needs.

These proposals, on which the South African Government has yet to announce its decisions, differ in some respects, which may prove important, from the arrangements for the University Grants Committee in Great Britain, and the significance of these differences may perhaps be seen in remarks which Prof. W. H. Hutt, of Cape Town, made at the Universities Congress. Prof. Hutt pointed out that in order to defend their independence when they are dependent on Government finance, universities have to weigh what they do and say in the light of their responsibilities, and they have to work together. This is not easy in South Africa, where the penetration of politics into university affairs now prevents Afrikaans and English universities from co-operating fully. Indeed, it is doubtful whether the conditions in which a University Grants Committee could function exist there, any more than in the United States.

Although this specific issue was not discussed at the International Congress on Science and Freedom

held at Hamburg, that Congress threw some light on the general principles which should govern the relations between governments and universities. To academic freedom, as to science, the most obvious danger comes with the enforcement of some extra-scientific or extra-academic canon of orthodoxy. Scientific advance and the functioning of the university are alike hindered when governments intervene indiscreetly and usurp or abolish the self-direction of university or scientist. The danger can arise not merely ideologically but also out of the utilitarian demands of the government making the grants. In Great Britain, apart from the discontinuance of the ear-marked grant, the Government has shown a most marked respect for university autonomy, as may be seen, for example, in the Treasury's latest reply to the recommendation of the Committee of Public Accounts that the books and accounts of the universities relating to expenditure of non-recurrent grants should be open to inspection by the Comptroller and Auditor General. Elsewhere, however, there is perhaps more danger that, in the legitimate initiation of projects in applied or fundamental research, governments may be less careful to avoid monopolizing them or allowing the objectives of their general policy to absorb too much of the available resources of the universities.

One of the essential conditions of scientific advance is that the scientist should have the freedom and resources to follow his own bent; and universities make their contribution to the advancement of learning, whether by teaching or research, under like conditions. When governments seek to order, instead of to foster, scientific or other creative activity, frustration sooner or later results. The first lesson a government has to learn in respect of the advancement of knowledge is to leave well alone, to see that the universities, the learned societies and scientific institutions and the individual scientists are not denied the necessary resources, and then to give them their head.

Prof. Ludwig Raiser, in an address at the Hamburg Congress on State support of universities and academic freedom, attached little significance to any audit by the State of the accounts of such an institution as the University Grants Committee, on the ground that the academic body itself would be no less concerned than the State to ensure the soundness of its accounts. He recognized, however, the importance of any such body as the University Grants Committee possessing the status enabling it to deal with the State on relatively equal terms, and to undertake the distribution of its funds expertly and impartially in a way that cannot be affected by any external pressure or sectional interests. Given such conditions, Prof. Raiser believes that financial support from the State will not prejudice academic freedom.

Such conditions, he recognized, are not universal even in the democratic countries. That they do not exist in the United States, for example, is one reason why the device of a University Grants Committee is regarded as unsuitable for introduction there. It would appear, moreover, that even if there were

achieved the general public understanding of the essential character of the relations between the universities and the State which it is intended to serve, application of the device in the United States would still be unsuitable. Nevertheless, in the United States as elsewhere, the public has to be convinced of the decisive importance of academic freedom both for the national welfare and for the advancement of science; otherwise the universities, scientific institutions, learned societies and professional associations are likely to be handicapped seriously in their work by the forces and passions released under loyalty-security investigations.

Dr. J. D. Millett, president of Miami University, described the problem as that of giving reality to the ideals of a free society, and said that the crucial issue of our time is the discovery and invention of satisfactory practices for enabling universities to do their work while maintaining their vital characteristics as centres of unhampered intellectual endeavour. These practices will necessarily vary from one society to another; dangers acute in one community may be less serious in another, where other factors may present a much greater threat to academic autonomy. Moreover, even in the academic world, there is the danger to which Prof. Jean Thibaud, of the University of Lyons, directed attention, that the age-factor itself may militate against a sufficiently adventurous administration of funds for the advancement of learning. Seniority may avoid the danger of indoctrination to which the entrusting of authority to younger people is liable, but it may itself fail to be sufficiently adventurous or receptive to new ideas, and such reluctance is usually accentuated if the administrative body is a government organization.

The great dangers of centralization were thus amply emphasized at the Hamburg Congress, and there was universal agreement that no central authority should have the right to dictate or to restrict the objectives of academic inquiry. Even more welcome, however, is the evidence in the United States, in the Commonwealth of Australia, in the Union of South Africa and in Japan that attempts to interfere with academic freedom—of investigation or of teaching—are meeting with vigorous protest and opposition. Resistance to such interference can scarcely fail to be strengthened by the exposition of general principles at the Hamburg Congress and the evidence of uniformity of world opinion on the issues at stake.

As Prof. M. Polanyi pointed out, when the State establishes institutions for the cultivation of science, it recognizes a realm of independent ideas and independent men. It admits that the requirements of this realm may demand consideration on an equal footing with the political and material interests of the society it guards, and by implication the State accepts also the obligation to foster the advancement of this realm under the guidance of recognized academic leaders. Academic freedom, as a principle for the efficient organization of the advancement of science, implies the right of independent thought, and Polanyi rightly insisted that for its defence and re-establishment to-day in the face of a more penetrating and comprehensive critique of its

foundations, liberty must be formulated in more concrete terms.

The situation in the universities in South Africa, where the threat to academic independence is much sharper than in Australia, illustrates the point admirably. At present there are about 240 non-European students at the University of the Witwatersrand out of a total of about 4,000, and some 219 non-Europeans at the University of Cape Town; the 222 non-European students at the University of Natal receive tuition in separate buildings and never come in contact with Europeans. Apart from one or two small teacher training colleges, the only other institution of higher learning in South Africa open to its 9 million non-Europeans (out of a total population of 12 millions) is the University College of Fort Hare, and of the 17,500 students in South Africa, only about 1,160 are non-Europeans.

The recent Commission on Higher Education for Africans in Central Africa, where the disparity in numbers between European and non-European population is even more marked, observed that an institution of university rank is an essential possession of a community which has reached a certain stage of development and has a sufficient population and adequate resources; and that although the number of university-trained Africans now employed in the Rhodesias and Nyasaland is small, it would be wrong to conclude that the need for such Africans is limited. Nevertheless, hitherto in South Africa only the Universities of Cape Town and the Witwatersrand have conformed to the essential university tradition that no regard should be had to race, religion or class when selecting candidates for admission. It is not contrary to university practice, as the Carr-Saunders Commission points out, to reserve certain halls of residence or hostels for particular classes of student; but it would be repugnant to university tradition deliberately to place hostels so reserved at a greater distance than other hostels from the centre of the university. The segregation of particular classes in separate buildings for tuition, as in the University of Natal, is a manifest breach of tradition.

The stress which the Commission laid in its report on these matters may appropriately be recalled here. No test of religious or political belief was to be imposed as a condition of becoming a member of the staff or a student at the proposed University of Rhodesia, and the effective autonomy of the University and the independence of its multi-racial basis of any political or other external pressure were emphasized. In South Africa, however, not only has it now become apparent that the *apartheid* policy of the Government does not imply, as has primarily been contended, the gradual extension of higher educational facilities for all racial sections: it has also become clear that there is no intention of providing equal facilities for non-Europeans, and that the transfer of non-European education from the Minister of Education to the Minister of Native Affairs presages an attempt to carry the principle of discrimination and segregation from top to bottom of the field of education.

In this situation the attacks continually made since 1948 on the Universities of Cape Town and the Witwatersrand, where there is a policy of non-segregation, by members of the Government and others, have now begun seriously to threaten the autonomy of these Universities. During the last session of the Union Parliament, the Minister of Education announced that the Cabinet would consider the problem of university *apartheid* during the recess, and expressed the hope that the universities would co-operate in ending what he termed an intolerable position. While he disclaimed any intention of threatening the academic freedom of the universities, when pressed on the point in Parliament, he denied that this would prevent the Government intervening on the colour question, and in September last a Government newspaper stated that there was every reason to suppose that the Government was firmly determined to come to the next session with the necessary legislation if the universities were not prepared to take the necessary steps themselves. Furthermore, the Union Government has already, on December 18, 1953, proclaimed a Commission "To investigate and report on the practicability and financial implications of providing separate training facilities for non-Europeans at universities".

It appears to be improbable that the Union Government will secure the voluntary co-operation of the two Universities in question. The Council of the University of the Witwatersrand recently affirmed the existing policy of the University, and the acting principal of the University of Cape Town, Prof. W. R. James, after expressing the view that the evil results of allowing European and non-European students to attend the same classes were wholly imaginary, said that if *apartheid* was enforced by legislation the University would presumably obey; but that it would be most unwilling to lose a freedom enjoyed by nearly all the great universities of the world. The National Union of South African Students, the 11,000 members of which are drawn mostly from the English-speaking universities, has taken a strong stand in defence of non-segregation and university autonomy, and in conjunction with the Students' Representative Councils of both universities is doing what it can to combat Government interference.

On February 15 a statement protesting at the projected extension of racial segregation in the South African universities was issued by the Bishop of Johannesburg and twenty other signatories. Questioning the need for interfering with existing practice in the open Universities of Cape Town and the Witwatersrand, and denying that friction or internal tensions have arisen through the open system, the statement declares that a university must be free to attract the most able students in every racial group, to welcome independence of outlook and to promote the fruitful interaction of mind upon mind. The very existence of the two open universities, it argues, has enhanced South Africa's reputation overseas and given concrete expression to the desire for goodwill between Europeans and non-Europeans. To destroy the open system and replace it with complete, or even with internal, segregation would destroy one

of the last bastions of tolerance and enlightenment in South Africa and drive bitterness and despair into the heart and mind of the non-European.

An independent and informed observer may well reflect that, when all allowance is made for the natural irritation of a government at the opposition, perhaps not always tactfully expressed, of student bodies to its policy and proposals, the open universities of South Africa in their resistance to the imposition of *apartheid* from outside are fulfilling the same functions that the medieval universities, and especially the University of Paris, once exercised in Europe. Even when no restrictions are placed on the Press, on the platform or on the polling booth or ballot box, a body of educated men, such as a university faculty, have an essential function to play in a free society; nor can they continue to test, criticize and re-assess existing institutions and beliefs, approving or disapproving in the light of the evidence available, unless their independence matches that responsibility. In the democratic State of to-day, with so much tendency towards centralization, this function of criticism and discussion by independent groups and associations is vital to the preservation of freedom of utterance, of thought and of association, and for the prevention of the transition, by an insidious process of attrition, of a democratic into a totalitarian regime. No university can tolerate such interference as is now threatened in South Africa without losing its soul, and university teachers, officials and students will have the respect and support of their colleagues elsewhere in the Commonwealth if they show something of the turbulence of the old medieval universities when academic privileges and rights were invaded.

We are not considering here the general question of segregation or *apartheid* in South Africa. The rest of the Commonwealth may regret a decision in that sense, may think it mistaken, and may even have to pay a heavy price for it; but the decision is one for South Africa to take. What is no less true is that if segregation is to be adopted as a policy in the open universities, it must be on their own free decision, as a result of reasoned argument and the balancing of pros and cons, and not at the external dictation of Government or even Parliament. Once university autonomy is thus infringed, the value of the university as an independent centre of informed impartial criticism disappears.

Neither the Universities Congress nor the Congress on Science and Freedom can have left the Government of South Africa in any doubt as to the absence of sympathy for any such inroads into academic freedom as are threatened. A modern community, however, has such imperative need of independent centres of reflexion, criticism and judgment that it is not too much to hope that wiser counsels will yet prevail. As Lord Lindsay once emphasized, the universities and the churches have an essential part to play in preventing the disintegration of a community in the modern world. Their freedom and functions are not merely the remnants of a medieval tradition. The freedom of the modern university, Mr. R. M. Hutchins, formerly chancellor of the

University of Chicago, has rightly said, is based on the proposition that societies require centres of independent thought and criticism if they are even to survive, and the function cannot be exercised unless freedom is guaranteed. The independence of thought that proceeds in a true university is thus too important to be curbed, even if it leads on occasion to the expression of reasoned views which are unpopular with a government or with particular groups or sections of a community.

How valuable that function of reflexion, discussion and criticism, and of social and educational experiment could be in the African world to-day is apparent from such a book as Prof. S. H. Frankel's "The Economic Impact on Under-developed Societies"*. Bringing out the complexity of the human and social problems involved in technical change, Prof. Frankel insists on the urgent need for a continent-wide study of these questions in Africa. In problems of human relations there are no easy or final solutions, and for solutions which offer hope of avoiding disintegration to be accepted they must be based on inquiry and study, the integrity and impartiality of which command confidence. Once confidence in the ability of a university institution to undertake such studies impartially and objectively is undermined, the basis of co-operation is destroyed. The Union Government might well reflect that hasty interference with academic freedom may destroy both the foundations of social order and one of the last hopes of averting racial disaster in Africa.

* *The Economic Impact on Under-developed Societies*. By Prof. S. H. Frankel. Pp. viii+170. (Oxford: Basil Blackwell, 1953.) 15s.

RESEARCH IN SCHISTOSOMIASIS AND ITS VECTORS

MIYAIRI'S discovery of the life-cycle of the fluke *Schistosoma japonicum* in 1913 raised hopes that the diseases caused by it and its allies might be controllable through their intermediate snail-hosts. These hopes were strengthened by Prof. R. T. Leiper's classical work in Egypt in 1915 on *S. haematobium* and *S. mansoni*; but, unfortunately, this early promise has not been completely fulfilled, and schistosomiasis remains one of the more intractable of tropical diseases.

It was assumed that a knowledge of the habits and ecology of the vector snails, once their identity had been established, might reveal stages in the cycle where mechanical, chemical, or biological control would be practicable. This assumption is probably sound; but the difficulties that have arisen have been mainly in connexion with the essential first step, which is to establish the identities of the vectors. Despite the vast amount of work that has been done on gastropod shells (under the urge of paleontological necessity and nineteenth-century fashion), relatively little attention has been paid to the snails that inhabit the shells, and it has become abundantly clear that the conchologists' 'species' are not recognized by the parasites. It also seems likely that

the ability to acquire and transmit schistosome infection is not a constant character even of a true biological species, but may be influenced by other factors, some environmental and some associated with infra-specific categories both of host and parasite. The problems are essentially biological, and the attack on them requires the closest collaboration between workers in different fields—experimentalists, ecologists and, especially, malacological taxonomists.

Since the disease is widespread, it is appropriate that the World Health Organization should co-ordinate national efforts and, to this end, a preliminary conference was recently held in Paris to compare notes on the taxonomic position and to discuss future research. The meeting was mainly concerned with the disease in Africa, and, as a major Colonial power in that continent, Britain is intimately concerned; but, unfortunately, it possesses no zoological organization whose normal responsibilities cover the whole field and which has all the necessary facilities.

Much of the work clearly falls within the scope of the British Museum (Natural History), which is acutely aware of the importance to medicine and animal husbandry of a more intensive study of the taxonomy of helminths and their vectors. Modern taxonomy requires, for the recognition of natural species, as complete a knowledge as can be obtained of the full extent of variation of all populations that can be shown to be normally interbreeding. Furthermore, taxonomy requires this knowledge over the whole range of environmental conditions under which the animals can, and do, exist. The same knowledge would also go a long way towards supplying the basic needs of those seeking for methods of control, and consequently the Colonial Medical Research Committee and the Museum are considering together suitable methods of providing research facilities. Inevitably financial consideration will limit the scope of their efforts.

In the circumstances, it is worth while directing the attention of biologists to the research fellowships which are being offered by the Civil Service Commission. Two classes of fellowships are offered: senior awards, of the value of £800–£1,000 a year, and junior awards, of the value of £500–£700, and the usual universities superannuation scheme applies to both. There is no age limit, but three years of post-graduate experience in research will be required of candidates seeking senior awards and two years of similar experience for junior awards. Fellowships are tenable for three years at a Government research establishment, "for research into subjects of importance to H.M. Government"—terms of award broad enough to cover the whole field of scientific endeavour. No doubt consideration would be given to the biological aspects of schistosomiasis and its vectors if candidates of suitable qualifications come forward. The problem is of outstanding importance from the points of view of both human affairs and biology, and it is to be hoped that this opportunity of advancing knowledge will be seized without delay.

A PIONEER OF MICROBIOLOGICAL EXPERIMENT

Abraham Trembley of Geneva

Scientist and Philosopher, 1710–1784. By Dr. John R. Baker. Pp. xix+259. (London: Edward Arnold and Co., 1952.) 35s. net.

THE lives and achievements of eminent scientific men have been, in general, well explored. Thus the biography of science tends, more and more, to works on lesser figures. It is therefore refreshing to encounter a careful study of a neglected yet highly distinguished exponent of scientific method. Dr. J. R. Baker is well known both as a cytologist and as the historian of the cell theory, quite apart from his editorship of the *Quarterly Journal of Microscopical Science* and his philosophical writings on freedom in science. He is indeed peculiarly well equipped for investigating the life-work of Trembley, to which he has devoted much care and skill. This most readable book is not likely to be superseded.

Not only students of biological history but also many of those who love beautiful books for their own sake know Trembley's "Mémoires pour servir à l'histoire d'un genre de polypes d'eau douce, à bras en forme de cornes" (Leyden, 1744). It is famous both for its admirable plates, drawn and engraved by Trembley's friend, Pieter Lyonet (1707–89)—one of the most skilled micro-anatomists of all time—and for its exquisite vignettes of the gardens and house in Holland where Trembley lived and worked during his most productive years. His achievements are most attractively presented by Dr. Baker in their scientific and social backgrounds.

Trembley was essentially an experimental physiologist who studied a few organisms, but those intensively. Such naturalists were rare in the century dominated by Linnaeus (1707–78), who sought to survey ever larger and larger numbers of species, to arrange them and to find patterns common among them. Of the physiological and intensive type of naturalist three contemporaries stand out pre-eminently—Trembley, Lyonet and, above all, de Réaumur (1683–1757). The three were in such close association that Dr. Baker has often to consider them together. For Trembley he makes the following claims, which we set out, almost in Dr. Baker's own words, though a little qualified here and there.

(1) He was the first serious student of animal reproduction by budding, the first to prove experimentally that the process is asexual, and the first to discover that budding of new individuals occurs in animals other than hydra and notably in Polyzoa and Annelida.

(2) He was the first to show that certain animals can be artificially multiplied by division and the first to make a single individual by grafting two animals together. Dr. Baker's additional claim that Trembley was the first to make permanent grafts of animal tissue should perhaps be reconsidered with reference to Tagliacozzi (1546–99) and certain even earlier workers.

(3) He discovered that Protozoa multiply by division, and form colonies when the division is not quite complete; he was among the first to witness cell-division and certainly the first to see it in a single-celled alga.

(4) He described some of the salient physical characters of protoplasm, 101 years before Dujardin.

(5) He was the first to describe the anatomy of a polyzoon. The general recognition of the animal nature of Polyzoon and sessile coelenterates was largely due to him.

(6) Of techniques, he introduced that of vital dyeing. He also adopted an injection process in which the colouring matter was forced through the body cavities by the animal's own muscular movements, thus demonstrating that the tentacles were hollow, their cavities being continuous with the main coelenteron.

His best-known achievements are, of course, his intensive study of the structure, habits, life-history, and methods of reproduction of *Hydra* and his extraordinarily skilled experiments with several species of this creature. For all of them he used no more than the most elementary apparatus. His microscopes were single lenses of very short focal length, each carefully mounted in a metal disk and held by a metal rod divided into segments by a series of universal joints. Trembley, like his friends Lyonet and Réaumur, was above everything a reliable and resourceful observer. He had a temperamental objection to hypothesis. Excess of caution has its nemesis, and these great observers, unlike their less cautious contemporaries, Buffon (1707-88) and Bonnet (1720-93), failed to find successors or to found schools of thought. Trembley was far from a voluminous writer, and Dr. Baker's careful bibliography contains only twenty-eight items, which include his philosophical, educational and religious works, together with reprints, reviews and contributions to journals. Few great naturalists have written so little and that little so good. Dr. Baker's book has a model index. It contains, under the heading 'Trembley, Abraham', a convenient chronological epitome of his life. In general, the biographical details are interwoven with the scientific with unusual skill. The book is beautifully illustrated and produced and is not expensive, as the prices of such things rule nowadays.

CHARLES SINGH

USE AND THEORY OF MATHEMATICAL ANALYSIS

Differential Equations

By Robert C. Yates. Pp. vii+215. (London: McGraw-Hill Publishing Co., Ltd., 1952.) 32s.

Advanced Mathematics in Physics and Engineering
By Prof. Arthur Bronwell. Pp. xvi+475. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 51s.

Complex Analysis

An Introduction to the Theory of Analytic Functions of One Complex Variable. By Prof. Lars V. Ahlfors. (International Series in Pure and Applied Mathematics.) Pp. xi+247. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 42s. 6d.

IN "Differential Equations", by Mr. R. C. Yates, of the United States Military Academy, West Point, a first course in differential equations is presented, suitable for the student of physics or technology; it covers the explicit solution of elementary first- and second-order equations, and includes brief introductions to the formalities of solution in series, Legendre and Bessel functions, simple partial differential equations and Fourier analysis. The

numerical methods of Runge-Kutta and Picard are given a short chapter. The author is well aware that the mathematician may cavil at the omission of existence theorems, convergence of series, and other matters of logical importance; but he is thinking primarily of the user and is content to refer to more advanced texts for these refinements. For students in the Armed Services, the need to relate mathematical methods to service problems is over-riding; and here Mr. Yates serves his readers well, since in most instances a new topic is introduced by means of particular and concrete problems, and the number of exercises for the student is ample. Moreover, Chapters 4, 8, 11, 15 and 19 bear the title "Summary and Review Problems", and in these the student can find an epitome of the preceding work and a further collection of relevant exercises. Perhaps Chapter 13, on Legendre and Bessel equations, should have been placed after Chapters 16 and 17 on partial differential equations, since then the bald statement that these are "two of the most important differential equations that occur in mathematical physics and engineering design" could be made more readily acceptable to the novice; but this is a very small blemish on a pleasant and useful introduction to a subject of high technical importance.

Prof. Arthur Bronwell is professor of electrical engineering in the North-Western University, Evanston, Ill.; naturally, his interests are on the technical side, and his volume, "Advanced Mathematics in Physics and Engineering", could be used as a sequel to that of Mr. Yates. His task is, however, more difficult, since he wishes not only to expound mathematical methods, such as infinite series, differential equations, vector analysis, Fourier series, complex variable and Laplace transform, but also to use these in an account of dynamics, circuit theory, heat flow, hydrodynamics and electromagnetic theory. Five hundred pages is perhaps too short for so vast a design, yet the chapters on these physical applications, while compact, are not obscure, though in one or two places more stress on the physical bases would have been helpful. The purely mathematical chapters do not appear to have received so much care in their construction; there are many loose and casual statements, while in the earlier paragraphs of Chapter 2 (complex numbers) and Chapter 10 (vector analysis) it is extremely difficult—and the novice might well find it impossible—to determine what is definition and what is inference. The notion that the technician need not understand a method so long as he can use it is antiquated; the really powerful mathematical tools must be understood in order to be efficiently used. Prof. Bronwell's massive compendium shows the use of many of these tools, but for a full understanding the reader should supplement accounts here given by referring to some of the authoritative texts mentioned in the chapter bibliographies.

As befits a pupil of Ernst Lindelöf's, Prof. L. V. Ahlfors writes for the mathematician. In "Complex Analysis" his topic is classical, though he has been able to find room for some fairly recent additions, notably subharmonic functions and Perron's method for solving Dirichlet's problem. There are, however, novelties of exposition. The student is not hastily presented with Cauchy's theorem; in fact, this does not appear until p. 88, and then only for a rectangle and a circle, the general theorem coming twenty pages later. Very wisely, the way is prepared by a thorough study of simple topological notions, and

by considerable attention to elementary conformal mappings. Good in itself, this study prepares the reader for the two-fold aspect, topological and analytical, of Cauchy's theorem, where Artin's ideas make for comparative simplicity. In effect, Prof. Ahlfors outs the topology of the subject to the minimum and then gives that minimum with the utmost clarity and precision. The calculus of residues receives meagre treatment: it is off the main line, and Lindelöf's own beautiful monograph is easy to obtain. Elliptic functions are excluded, Prof. Ahlfors expressly referring the reader to Copeston's classical book on the complex variable. Space thus saved is given to two chapters, one on the recent work referred to above, and the other to the theory of multiply-valued functions, which is clear enough as an introduction but scarcely goes far enough to be either satisfying or provocative; twenty pages more here might have explored the main foundations of algebraic functions. In all, this is a clear, authoritative, up-to-date treatise, thoroughly suitable for the undergraduate beginning to specialize in function theory.

OCCURRENCE OF PETROLEUM IN THE EASTERN HEMISPHERE

The World's Oilfields

The Eastern Hemisphere. Editor: Prof. V. C. Illing. (The Science of Petroleum, Vol. 6, Part 1.) Pp. viii + 174. (London, New York and Toronto: Oxford University Press, 1953.) 52s. 6d. net.

LIKE the previous addenda to "The Science of Petroleum", this is a very fine book. Written by a selection of contributors, each vessel in a particular terrain, it deals with the subject as a whole and forms a work of reference limited only by the knowledge available at the time of writing. Therein, as is natural, may lie a few limitations. So far as petroleum at present is concerned, the "Eastern Hemisphere" is chiefly Europe and the Middle East. In the case of Europe, information that is, or has been, readily accessible (such as that regarding Germany, Poland and Roumania) is already fairly well known; what has not been accessible and was mostly unknown when volume 1 of "The Science of Petroleum" was published in 1938 (for example, developments in Austria and Hungary) includes the more important new fields largely developed subsequent to the outbreak of the Second World War and still behind the Iron Curtain. The result is that in these sections, where knowledge of production is sparse, the treatment seems rather heavily weighted on the side of general geology. This is so, to some extent, even with the important fields of the Middle East, on which however, by reason of their broader outlook, the articles by Lees are refreshing to read. Although oilfields are sub-surface affairs, it is natural that exploration, their discovery, delimitation, development and handling of production should be of the widest interest. One is consequently apt to miss the treatment in Vol. 1, wherein a single part of discussion of individual oilfields was in proportion to some five parts of the general aspects of production concerned with geophysics, siting, drilling, field-engineering and transportation.

The present volume is therefore of greatest importance to students and workers in the field of petroleum geology. The pattern of treatment in the

sub-sections is to follow a short introduction with details of the stratigraphy and tectonics of the area concerned. The oil-source rocks are then discussed separately. Good use is made throughout of effective tabulation, and maps and diagrams are excellent. The sections dealing with the Far East and Australasia, and with Africa, contain articles by fourteen separate authors. They vary in length; but the majority, though short, succeed in giving general outlines of the oil geology of the extensive but not very productive areas concerned. In this way, the implications of subsequently acquired information or discovery afterwards made can readily be fitted in.

Prof. Illing and his contributors are to be congratulated on producing a volume which will be of permanent value in the study of the occurrence of petroleum.

S. J. M. AULD

MARGINAL LAND IN BRITAIN

Marginal Land In Britain

By Prof. W. Ellison. Pp. 224 + 16 plates. (London: Geoffrey Bles, 1953.) 25s. net.

PUBLIC attention has been directed repeatedly in Great Britain to the possibilities of marginal land improvement during the past ten years or so, and the absence of any comprehensive book on the subject has meant a substantial gap in agricultural literature. This gap is now filled very adequately by Prof. W. Ellison's book. It cannot be easy to write a book which will be read with interest and profit by both the farmer, on one hand, and the scientist and administrator on the other. Prof. Ellison, we know, is an enthusiast for reclamation and rehabilitation of the land and farmsteads of British uplands; but unlike so many agricultural enthusiasts before him, he has been content to give an ungarnished factual account of the nature and extent of the problem, drawing on his own and other people's practical experience to show with facts and figures how production can be increased from this type of land, and at what cost. It is a great merit of the book that the agricultural problem of marginal land in the uplands is always kept in perspective, both in relation to its alternative use for forestry and water-gathering grounds, and to the needs of the lowland farmer upon whom the upland farmer so largely depends.

The book begins with a historical introduction and goes on to describe the findings of the various committees which have considered the problem in recent years. The different types of marginal land in Great Britain are defined and delineated on folding maps. There follow valuable sections on the methods of improvement appropriate to these different types and on the utilization of the resulting increase in production of crops and grass. The author's discussion of the extent to which, in the uplands, rehabilitation of the farm-houses, buildings, roads and services must accompany improvement to the land is based on actual surveys, which emphasize the high capital costs involved.

If there is an omission from this otherwise well-balanced book, it is perhaps the relatively slight reference to the personal factors in this problem—the labour force (family and hired); the landlord; and, most important, the abilities and shortcomings of the farmer himself.

THE AMATEUR SCIENTIST IN BRITAIN (I)

By R. BRIGHTMAN

IN his presidential address to the British Association at Liverpool in September, "speaking as a professional scientist who has only recently turned amateur", Sir Edward Appleton made generous acknowledgment of the immeasurable debt which science owes to the amateur scientist. This welcome tribute was supported, moreover, by others at Liverpool, notably at the Assembly of Corresponding Societies when Dr. P. M. Butler, for example, referring to the work of amateur naturalists in Lancashire, particularly in botany, and especially around Manchester and Oldham early in the nineteenth century, pointed out that before 1850 some of these amateurs had an international reputation, especially in the study of mosses. An account of the work of some of these men was given by Mr. J. Cash in his book "Where There's a Will There's a Way", published in 1873¹. The tradition persisted well into this century. Mr. F. E. Milsom, for example, a chemist who died in December 1946, after many years service at Huddersfield in the British Dyestuffs Corporation and the Dyestuffs Division of Imperial Chemical Industries, Ltd., had an international reputation for his study of the bryophytes, and particularly the hepatics; from 1934 he was the referee of the British Bryological Society for British and European hepatics, and he also was an authority on the mosses.

Nevertheless, for the past half-century or so many comments have been made on the decline of the amateur in science, both in numbers and importance. In his presidential address to the British Association at York in 1906², Prof. E. Ray Lankester, for example, regretting this decline, remarked that the field naturalists seemed then not to be so numerous and active as formerly, and suggested that the organization and professional character of scientific work were to a large extent the cause of this decline in its attraction for the amateur. His comment that the mechanics' institutes and lecture societies of the days of Lord Brougham had given place to a very large extent to other entertainments, more diverting, but not really more capable of giving pleasure than those in which science was popularized, and that the decadence was also "due in some measure to the increased general demand for a kind of manufactured gaiety, readily sent out in these days of easy transport from the great centres of fashionable amusement to the provinces and rural districts", has a very topical ring.

In the following year, Prof. H. B. Dixon, in a presidential address to the Manchester Literary and Philosophical Society³, deplored in particular the belief that professional men of science were jealous of the amateur, and by a conspiracy of silence or contempt sought to obscure his merits and so maintain their prestige. Prof. Dixon quoted in this address from a farewell letter written by Dr. Edmund Schunck to the Society some years earlier deploring the increase of the professional element and the disappearance of the amateur from membership of the Society, and making an impressive plea for the cultivation of the amateur in science. The amateur, Prof. Dixon urged, possessed patience, skill and enthusiasm and the advantage of an open mind. He could bring to discussion a freshness of ideas which

more than compensated for any possible defects of critical judgment. Prof. Dixon saw no reason in the nature of things why a professional in one science should not be a successful amateur in another. Probably no more stimulating ideas are struck than at the personal contact of two minds trained in different sciences.

A similar theme was pursued by Prof. H. A. Miers in addressing the Conference of Corresponding Societies at the British Association meeting in Dublin in 1908⁴. While in recent years opportunities for scientific education had expanded, at the same time the gulf between the amateur and the trained scientist had widened, and Prof. Miers was concerned with the possibility of bridging this gap through the work of the corresponding societies and in other ways. Even then it was, he said, more difficult for the amateur to get adequate insight of the recent advances of science without a course of special reading or without attempting to master treatises for which he required some kind of preliminary training. Moreover, the intelligent amateur no longer necessarily belonged to a class quite outside scientific circles as formerly, but was frequently quite learned in one branch of science though he may be the merest amateur in another. Yet when he travelled outside his own subject he was in danger of being placed in a position somewhat similar to that of his predecessor, the amateur of sixty years ago. Not only was the position of the amateur unsatisfactory in regard to scientific literature, but still more was it true as to the societies. The scientific societies were becoming highly specialized in their membership, and it was more difficult for even the intelligent amateur to gain anything from the proceedings and meetings of these societies. In this situation, which is more intense to-day, Prof. Miers thought that the best hope of improvement lay in the work of the local societies, and particularly in the sort of field-work which they could initiate, so that the professional and the amateur could find common ground. Anything, he urged, that tended to break down the barrier between the professional and amateur, between expert and layman, was for the good of scientific progress, and he referred in this connexion to a previous protest by Mr. Lamplugh, president of the Yorkshire Naturalists' Union, against the unhealthy distinction between amateur and professional and his plea for the amateur spirit in scientific work.

Nearly twenty years later, addressing the Conference of Delegates of Corresponding Societies at Oxford in 1926⁵, Sir John Russell remarked that although the amateur with a few shilling's worth of apparatus was no longer able, in Faraday's words, "to make himself as considerable" as people with long specialized training working in well-equipped laboratories, the amateur who was prepared to take trouble still had his place in the advancement of knowledge. In the observational sciences—botany, geology, anthropology, archaeology—he was able not only to interest himself but also to help others. Sir John proceeded then to discuss the scope which regional surveys offered for the activities and wide outlook of the amateur worker. Like other scientific

work such work was team-work, but such as the corresponding societies could do, usually, best in consultation with the professional workers of the university schools. A regional survey gave a survey of a district as an environment for human beings—an account of its physical features, its natural characteristics, its flora, fauna, etc., culminating in a study of the ways in which they affect human life and activity. It was this human aspect that gave the non-professional worker his opportunity, for his close touch with human affairs enabled him to appreciate and to express the human point of view.

Experience of the numerous regional surveys of recent years has amply confirmed the truth of Sir John Russell's remarks. Nevertheless, in spite of this and the long tradition of the amateur worker, particularly in botany, both Dr. R. S. Bates in his book, "Scientific Societies in the United States", and Prof. A. D. Ritchie in a contribution to the symposium "Science, the Universities and the Modern Crisis" of the Manchester Literary and Philosophical Society, could note a tendency for the specialist to despise and ignore the amateur. Prof. Ritchie pointed out that there used to be an enlightened public of amateurs to which every specialist had to appeal to earn recognition. "Now," remarked Prof. Ritchie, "amateurs are unwanted, get snubbed if they interfere and have mostly died off."

There is, however, now less danger of the amateur tradition in science dying out than there was in the early years of the century. Since the War there has been an encouraging increase in the activities of the amateur scientist, particularly in biology, in many countries. Notably in the United States, serious efforts are being made to foster the work of the amateur scientist, and to see how his contribution to the advance of science can be made most fruitful. This tendency is to be welcomed on several grounds. As the title alone of Dr. Dorothy Stimson's book "Scientists and Amateurs" reminds us, the Royal Society began with amateurs. Even earlier than that date, as Canon O. E. Raven pointed out in his study of the making of the modern world, "English Naturalists from Neokam to Ray", there were scientists who could be clearly described as amateurs. Indeed, in his more recent Gifford Lectures, "Natural Religion and Christian Theology", Dr. Raven argued that Robert Hooke was the first professional scientist in Britain. Moreover, particularly in his book on the English naturalists, Raven insists that Bacon and those Christian thinkers who followed him and founded the Royal Society were not primarily concerned with the benefit of their discoveries to mankind. Their basic conviction was that from the accurate understanding of the Creation they could gain a true and effective knowledge of the Creator, and so could bring the life of mankind into a fuller and more intelligent correspondence with His will. They regarded theory and practice as inevitably interdependent. This appeal to factual evidence, to observation and experiment, marks, as Raven shows, a revolution in the method of philosophy which had prevailed until then, which is perhaps even more strikingly illustrated in the life and writings of the Norfolk doctor and naturalist, Sir Thomas Browne, best known for his "Religio Medici". The coming of this modern scientific outlook was, in fact, not just a succession of specialized workers, but was characterized by a general change in outlook among educated men, which is perhaps better appreciated when illustrated in ordinary men

such as Sir Thomas Browne, rather than among those men of genius who were the effective leaders of the Royal Society during its first generation.

Both in this book and in his Herbert Spencer Lecture¹¹, Raven lays much stress on this aspect. These first scientists were not only men of deep religious conviction, but also were possessed of a genuine passion to see life steadily and to see it whole, and of a no less genuine belief that in studying the works of creation they were enlarging man's knowledge of the wisdom of God. Their motive was not solely utilitarian. They cared profoundly for the well-being of their fellows and the benefit which a truer knowledge and wise use of resources would bring. But they were also fascinated by the sheer interest of their explorations, and convinced that in the search for deeper understanding they had a worthy creative bond. That, I think, well expresses one reason why it is important to-day that the amateur tradition in science should be maintained. It is a corrective, as well as an inspiration, to science itself, apart altogether from its contribution to the atmosphere or climate of opinion in which alike the prosecution of scientific work and the application of its results are most fruitful.

Amateurs in science then, in the accepted sense of the word, denoting those that practice their art not as a livelihood, but for the love of it, were to be found in many places and in many classes of people in the latter part of the seventeenth century—mainly in circles sufficiently wealthy or leisured for its pursuit. The other period of this feature which may be noted here is that to which Ornstein directs attention—the way in which unions of scientific workers became the dominating feature of scientific work. They concentrated, he points out, groups of scientists at one place, who performed experiments and carried out investigations impossible to individuals. They encouraged individuals and gave them opportunity and leisure and financial support for scientific work, becoming centres of scientific information and publishing and translating books; they dispelled numerous popular errors and at times endeavoured to reach the general public by means of lectures. They were concerned with trade and commerce as well as science. To them also was due the development of the scientific laboratory, the creation of national observatories, and the standardization and improvement of instruments and technique.

Nor is it surprising to find that the amateur is equally prominent in the eighteenth century, and with, for example, clergyman like Stephen Hales or medical men like John Mayow, who made important contributions to our knowledge of the gases of the atmosphere. As F. Sherwood Taylor pointed out in a paper on "The Teaching of the Physical Sciences at the end of the Eighteenth Century"¹², almost the only scientific professions were those of the medical man and, to a less extent, the engineer, mechanical or military. The professional scientist, in to-day's sense of the word, scarcely existed until the nineteenth century was advanced.

What merits notice here is the way the amateur tradition persisted well into the nineteenth century even when the professional scientist had well established himself outside the ranks of the medical men or the engineers. It is less surprising that as the century opened Edward Jenner (1749-1823) should be scarcely more distinguished as the discoverer and pioneer of vaccination than as the naturalist who gave the first detailed and accurate account of the

eviction by the newly hatched cuckoo of the eggs and fledglings of the foster parents, and even communicated to the Royal Society just before his death important observations on the migration of birds. At the end of the century, however, we can point to Sir John Evans (born in the year of Jenner's death), the professional chemist and paper manufacturer whose amateur interest in geology and archaeology won him as much distinction, including the fellowship of the Royal Society, as his original field of study. Sir Joseph Prestwich, with whom Sir John Evans was first associated in investigations of flint implements in old river gravels, was a wine merchant who took up geology as an amateur before he ultimately became a professional geologist and professor. Sir Charles Lyell, General Pitt-Rivers, Sir John Lubbock and Sir Norman Lockyer (the first editor of *Nature*) are others of the same period who first distinguished themselves in science as amateurs, and only in the latter part of their careers could Lyell or Lockyer be fairly described as professional geologist or astronomer.

The most important point, however, is brought out not so much by the fact that men trained in one profession or in one branch of science can make distinguished and important contributions to the advance of knowledge in quite another sphere which they took up for its own intrinsic interest to them. Particularly where it is a matter of two different scientific disciplines, it could then be argued that one serves as a basis for the other, and that we are concerned with transfer from one professional discipline to another rather than with a strictly amateur activity. The amateur aspect is none the less important, but its value is perhaps seen more clearly in the contributions which came, especially in the first half of the nineteenth century, from Hugh Miller, the journeyman mason of Cromarty, whose "Old Red Sandstone" is essentially the work of an amateur geologist, or the amateur naturalists of Lancashire already mentioned.

Sir John Mand also referred to this aspect in a recent address on the "University Graduate"¹⁸. Sir John referred to a characteristic which is very difficult to describe but which is of special value to-day, and he described it as the mark of the amateur in the best sense of the word—the amateur who does not claim to be a professional or an expert and who, where there is need of expert knowledge, knows that he must consult the professional, but also knows that having consulted him he may well be right not to take his advice; the amateur who loves his job, without sentimentality, and really enjoys his working hours so that there is no clear distinction between the good life as it is lived while he earns his livelihood, and the good life that is lived during his so-called leisure.

This outlook or quality of the amateur accordingly, quite apart from the direct contribution which the amateur scientist can make to the advancement of knowledge, is thus of value in correcting the fragmentation of modern life and in encouraging that wholeness of living which the modern world greatly needs. At the philosophical level it is unlikely that the amateur has any significant contribution to make, but at the practical level of human ecology, such as finds expression in the writings of Dr. K. E. Barlow and others, the multiplicity of amateur activity in varied fields of science could do much to restore sanity to civilization and encourage the receptivity which determines so largely the adjustment of society to a changing environment. In this connexion it is pertinent to recall that industry itself

in the nineteenth century owed something to the amateur. W. Weldon, the journalist, whose interest in industrial chemistry led him to the discovery of the process bearing his name for the regeneration of manganese dioxide in chlorine manufacture, is perhaps the outstanding example. The discovery revolutionized the industry, and Weldon himself was elected a fellow of the Royal Society in 1882. Modern steel-making is founded upon three British inventions, all of which came from outside the industry. The Bessemer and Siemens' converter and open-hearth processes for making steel as it is known to-day both depended on the iron ore used being almost entirely free from phosphorus. The basic process which made phosphoric ores suitable for steel-making was invented by S. G. Thomas, a Metropolitan police court clerk: as a Middlesbrough ironmaster put it, "An amateur pressed it upon the ironmakers".

As has already been said, important contributions to scientific knowledge are still being made by amateur scientists in various fields. At the annual general meeting of the Edward Grey Institute of Field Ornithology, Oxford, on October 27, 1950, Dr. D. Lack, its director, referred to major advances in five fields of zoology in which the amateur naturalist as well as the professional zoologist had participated¹⁴. First, Prof. W. Rowan, speculating and later experimenting on the immediate factors causing birds to migrate, discovered that increased day-length can bring the sexual organs to maturity outside the normal breeding season, and even in midwinter. This has led to important advances in reproductive physiology, not only in birds but also in other vertebrates.

Secondly, the apparently trivial 'splitting' of the bird taxonomists eventually provided a firm basis of comparative material for the subspecies concept, which led in turn to the dramatic discovery of two subspecies of the same species (the great tit), living together in the same region and "behaving as good species".

Thirdly, the field-study of bird behaviour led first to a purely ornithological discovery, Eliot Howard's theory of territory, and later, assisted by observations on captive birds, to important new concepts concerning the nature of instinctive or innate behaviour in animals. The studies started by Lorenz and Tinbergen on birds have later been most profitably extended, particularly to fish and to insects.

Fourthly, bird-ringing has put the study of migration on a precise and quantitative basis, while the recent observations on visible migration and some spectacular results with homing experiments have renewed speculation on the method or methods by which birds find their way.

Finally, there is the new study of "population dynamics", or "population ecology". Through long-term censuses, the fluctuations in certain bird populations are more accurately known than those of any other animal. An unexpected by-product of the bird-ringing scheme has been to establish not only how long wild birds are capable of living, but also their average expectation of further life. The latter is far shorter than popularly believed—only about one year in the case of the robin, for example. The reproductive-rate of birds and the factors determining it have also been the subject of precise and quantitative study. Indeed, it should soon be possible to obtain a complete life-equation for a bird living under normal conditions, and this should help to advance the study of the factors which control population density in animals.

The co-operative field-work of the British Trust for Ornithology, which was founded in 1933 to maintain the field-work already started at the University of Oxford between the professional zoologist and the amateur, is of some interest in this connexion. It should be remembered, of course, that, as Mr. Bruce Campbell has pointed out¹⁰, very similar co-operative methods were used by the British Association and by the British Ornithologists' Club in their studies of bird migration many years ago, and we may even see the germ of the idea in Gilbert White's circle of correspondents. In a co-operative inquiry, observers all over the country are linked together by a central organizer, to whom they send in their information, and who is responsible for drawing up the final report and for calling in expert advice as he requires it. It has been a feature of inquiries run by the Trust that the organizer has seldom been a professional zoologist, but that the inquiry has been agreed upon and the report submitted to a research or advisory scientific committee, on which sit both professional (*sensu stricto*) zoologists and men who have devoted the free hours of a lifetime to studying birds. Usually one or two members are particularly interested in each inquiry and keep in close touch with the organizer.

Careful choice of subject in such inquiries is, of course, required, and the manner in which it is conducted may also be modified. An organizer may conduct his inquiry through a limited group of correspondents of proved experience, or he may delegate to local organizers, who can sieve information in their own regions before sending it on to him. A good example of this is the ten-year census of the great-crested grebe, over a sample area mainly in the English Midlands, which began in 1946 as a follow-up to the original national survey of 1931.

The co-operative technique has not only been used for bird problems. In Monica Shorten's study of the status of the grey and red squirrels in Britain¹¹, a research worker at the Bureau of Animal Population, Oxford, corresponded with voluntary observers all over the country, while Sir William L. Taylor's surveys of the distribution of wild cats, capercaillie and wild deer on Forestry Commission areas¹² have shown how the staff of a widespread organization can contribute useful data as a by-product of their main work.

The above contributions to zoology have been made partly by professional and partly by amateur naturalists. Both, it is scarcely necessary to add, are scientists. The cleavage imagined by some nature-writers to exist between the cold-blooded scientist and the warm-hearted amateur is, of course, a fiction. Thus the amateur scientist still continues to add materially to ornithology. Incidentally, it may be noted that in his book, "The Art of Scientific Investigation"¹³, Prof. W. I. B. Beveridge remarks, "I have noticed that in England a great many research workers in both the biological and non-biological sciences are, or have been in their youth, keen naturalists. The pursuing of some branch of natural history as a hobby by a young man may be a valuable indication of an aptitude for research".

At the Birmingham meeting of the British Association, in a paper read to the Education Section, Dr. A. G. Lowndes quoted two instances of research carried out at schools in spite of the absence of costly apparatus¹⁴. A wave passing up a flagellum was first photographed, not at the University of Cambridge, but at Marlborough College. The myth

that the egg of the dogfish consists of an enormous amount of yolk was not exposed and exploded at a university. The initial work was done at Rugby School during ordinary class teaching. A promising feature of recent years is, in fact, the extent to which opportunities are opening up for effective participation by young amateurs in scientific work. The observations on the natural history of starlings, recording the results of twenty-five years bird ringing at Bootham School, York, under the direction of Mr. Clifford J. Smith, is one example of activities which the British Trust for Ornithology has done much to foster during the past twenty years. The survey has shown that in winter we have starlings of two races in Britain: the residents that nest here and those that come from Europe but nest abroad and cannot interbreed with our native birds. Only a preliminary report is yet available, but it is hoped that much of the survey will be published in more permanent form.

Another example of what enterprise and imagination can do to demonstrate the nature of scientific work to the schoolboy and to provide opportunity of participating in the making of observations of value to science is to be seen in the oceanographic expedition to the North Sea organized early in 1953 for science sixth-form boys from the Watford Grammar School¹⁵. The expedition consisted of eleven boys and one master, and the party was distributed among the trawlers so that in each ship there was one boy who carried out the duties of a biologist and one who acted as chemist, physicist and meteorologist. The biologist was to collect otoliths and connect their age with their length and to investigate the stomach contents of as many fish as possible. The others were to study the trawl contents to gain information about the North Sea as it was in the last glaciation and during the subsequent emergence of dry land, and build up a complete picture of the conditions of North Sea fishing. The party obtained fifty-two samples of salt water and 130 sets of meteorological recordings, including surface temperature, relative humidity, wind, sea, swell and sounding and position and time.

The venture clearly has features in common with the expeditions of the British Schools Exploring Society, notably that to British Columbia in 1953, on which scientific work undertaken included the mapping of the region of the north-western arm of Lake Stuart¹⁶. Two bathymetric cross-sections undertaken showed interesting results relating to the general form of the lake basin. A main meteorological station was opened at base camp and regular observations were taken, and one team was concerned with the micro-meteorology of the forest trunk-space. Biologists on the expedition made collections of pressed plants and of lesser known insects from the deciduous and coniferous forests as well as from the alpine zone of the Mount Sydney Williams massif. Detailed notes of bird and animal life were also made.

Yet another instance is to be seen in the extensive survey of weather in the Cairngorms conducted in the summer of 1953 at five high-altitude weather stations by teams of undergraduates and senior schoolboys¹⁷. The practicability of camping in such tough conditions—three of the camps were at more than 3,000 ft.—was demonstrated in 1952 by a pilot expedition from the Cambridge University Rover Scouts, and last year's expedition was planned in the light of that experience. All the stations were

at least five miles walk from the base camp at Glenmore Lodge. Weather observation did not take up the whole time after the camps had been made secure against bad weather. Once the camps were established, the observers turned their attention to many other geographical jobs. The Cambridge geographers spent ten days in late June excavating the near-permanent snow patches to obtain cross-sections of the banding in the snow. Another team was able to study and map beautiful miniature sand spits by their camp at Loch Avon. More than a hundred people were involved in this survey, but the vast amount of information collected only covers a small part of one year. In future it is hoped to obtain more samples of the weather in the Cairngorms, probably extending the survey into other seasons. This work, of which a full report is to be published, should appeal particularly to schools.

A similar but even more interesting development, from the point of view of the young amateur scientist, is the growth of the Tarn Survey Project of the summer of 1947, when Brathay Hall was first opened as a holiday centre for boys from industry, into the Brathay Exploration Group in 1950. The idea originated when Brian Ware, while deputy warden of Brathay Hall, was told by Vaughan Lewis, of the Department of Geography of the University of Cambridge, of the absence of detailed information about the depths of the tarns in the Lake District, and the serious obstacle it constituted to research on glacial erosion in the District. The challenge of this relatively simple but real task of exploration led to the organization, in August 1947, of an expedition to Easedale Tarn, followed later by a second expedition to Angle Tarn under Bowfell, for which purpose a new collapsible and portable boat was devised. The success of these two expeditions encouraged the organization of a more ambitious expedition in the following year to Bleawater, and from that time the principle of recruiting boys equally from schools and industry became the basis for future developments, and the principle of using a mountain camp as base was established. It also proved the value of recruiting junior leaders for expeditions from among university undergraduates. Four other parties were organized in August and September 1949, and for the following year plans were laid on the assumption that Brathay Hall itself would again be the base for expeditions. It was also realized that if the Tarn Surveys were to take on a permanent and useful form, suitable separate headquarters would be needed, and the survey would require broadening to include a wide range of field-study. The 1950 surveys in the Lake District were handicapped by bad weather, but notwithstanding, successful surveys of three tarns were made, and an expedition to the Jotunheim Mountains in Norway was also organized, where the members undertook definite tasks in a programme of research organized by the Department of Geography at Cambridge. From a base-camp set up at Vindal, one party carried out a plane table survey of the glacial features of a corrie, under Glittertind, which had not previously been mapped in detail, and made observations and measurements to determine the nature of a large ice apron in the corrie. The second party carried out a detailed sounding of Juvatnet, a lake lying under the ice cliffs of the Kjeldan corrie glacier.

The following year marked the transition from the Tarn Surveys, run as part of the 'Holidays with Purpose' scheme, to the fully constituted and self-

contained Exploration Group. The new headquarters could not be built during the year; but the programme of field-work included the detailed charting of five more tarns and some preliminary work on tarn temperature régimes, and in freshwater biology and botany. Previous experience had indicated that a party of eight boys and two leaders was the largest practical unit for field-work, and that by far the most successful parties were those in which schools and industry were equally represented, and in which individual schools and firms were represented by one or two boys rather than by three or four, and in which there was a nucleus of boys who had been members of at least one previous expedition. During this period, 1947-51, more than 250 boys participated in the expeditions and a panel of some thirty voluntary leaders was built up, while twenty tarns were charted for the first time.

The following year, 1952, the first in which the new headquarters in the Brathay Estate were available, four expeditions in the Lake District were organized, one surveying Codale Tarn and Hayswater; another to Angle Tarn above Patterdale; a third to Watendlath Tarn; and a fourth to Sty Head Tarn. There was also organized an expedition to the Jotunheim in Norway; but bad weather severely curtailed the major projects for a temperature survey of Juvatnet, and tunnelling through the firm of the Kjeldan corrie glacier.

In the summer of 1953 three of the four expeditions commenced an intensive survey of the Bleawater corrie, under High Street, including the temperature régime, a study of the geomorphology of the corrie, including the making of an accurate profile from the ridge of High Street, through the main and lower corries, to the Haweswater valley; a profile of the neighbouring Riggindale; and an examination of the widespread and varied evidence of glaciation, and a study of the meteorology of the corrie, including particularly an investigation into the wind circulation as well as a pioneer botanical survey. The fourth expedition was divided into two groups, one of which undertook a temperature survey of Easedale Tarn and the other a survey and sounding of Burnmoor Tarn, which does not lie in a corrie. In August 1953 a third expedition went to Norway to complete the work carried out on the previous year, including the completion of the tunnel and the exploration of the *randkluft* below its inner end; an examination of the well-developed stone rings lying around Juvasshytte; and a survey of plants, from the almost barren plateau at just over 6,000 ft. down to the tree line at about 4,000 ft. In the same month an expedition was arranged to Iceland which, although independent, maintained close liaison with an expedition from the University of Cambridge. From the base camp at the north end of Kaldidalur a weather station was set up at an altitude of 3,900 ft. A plane-table survey of a volcanic crater was made on a scale of 1/5,000, while another party surveyed by compass and 100-ft. tape an ice-margin lake—Thorisdalurvatn—on the east side of Thorisdalur. From the base camp a vertical soil section 11 ft. deep was dug in a stream bank, and a plane-table traverse with aneroid heights was made of the Geita from Kaldidalur to the Hvita Plain.

Under expert guidance, the amateur archaeologist also frequently helps his professional colleague. In 1951, for example, a broadhead three-note bone whistle dated from the Iron Age was discovered by members of a Study Course in Field Archaeology at

the Malham Tarn Field Study Centre in excavating a burial site between Gordale Beck and the road to Malham Tarn.

(To be continued)

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MINERAL DRESSING AT THE ROYAL SCHOOL OF MINES, LONDON

WITHIN recent decades the increasing industrial demand for engineering metals and non-metallic minerals has led to the exploitation of mineral deposits too low in grade or too complex in ore structure to be profitably worked by the simpler methods in use thirty years ago. Though the demand still rises steadily, most of the older deposits are already in full production or even approaching exhaustion. Difficulties of climate, power, access and mechanized mining have been overcome to a gratifying extent; but the extraction of small quantities of valuable material from a large amount of associated host-rock still presents many difficulties.

In addition to modernized developments of the older methods of mineral dressing, in which gravity, ferromagnetism, electrical conductivity and the skill of the hydro-metallurgist are exercised, the process of froth-flotation has grown in importance. It provides the only method of concentration in many

ore-dressing plants, and is used at some point in most of the others. The process is applied to finely ground ore pulped with water. Each ore particle must be so small that its settling velocity is of the Stokesian rather than the Newtonian order. There are two main reasons for this: first, the separation of value from waste depends on differences between the surface tensions of the particles undergoing treatment, and these differences cannot be exploited if the masses of the reacting particles introduce a high gravitational pull; secondly, the desired particles must be freed by grinding from those which are to be rejected, and this liberation is only effective when a substantial part of the ore has been ground well below 50 μ . Particles only a few microns in diameter are usually responsive to treatment.

Liberation by wet grinding is practised under close physical control. The prepared ore-pulp next receives small additions of chemicals which control flocculation, detergency and the surface characteristics of the various minerals in aqueous suspension. The pH must be held within defined limits during the whole of the treatment. A copious supply of air-bells is next blown through the pulp. As a result, particles which are relatively aerophilic are attracted into the interface between water and air and rise to the surface of the pulp where, with the help of a suitable frothing chemical, they form an unstable mineralized froth which is removed from the system. Huge tonnages of ore are treated daily along these lines.

In recognition of the vital importance to industry of a trained scientific outlook in developing and operating such processes as the one outlined above, the University of London instituted a degree course in mineral dressing in 1952. This is a B.Sc. option (engineering) in metallurgy, and it carries with it the associateship of the Royal School of Mines. On March 17 the new laboratories built in connexion with this degree course and its associated research



Fig. 1. Crushing room. Right, jaw crusher, Symons cone crusher, set of rolls, automatic sample splitter and a Sherwen screen; left, small crushing machines. Ore is moved by electric crane and mono-rail.

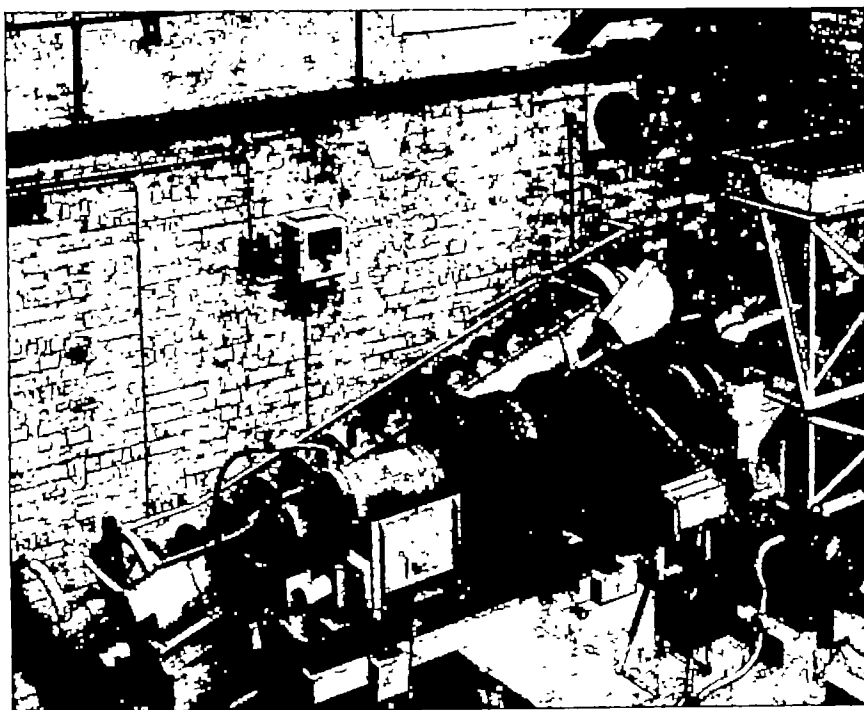


Fig. 2. Small wet-grinding mill in closed circuit with an Atkine classifier

activities were 'at home' to visiting scientists, when a comprehensive range of dry-crushing, wet-grinding and sampling machines were demonstrated. All the machines are protected by a dust-control system which permits virtually all the rock treated to be recovered in the end-products. The crushing section is under negative pressure, so that the main testing laboratories are not contaminated by air-borne mineral dusts. In the research section, which is reached through air-locks, all air is spray-washed and filtered before entry, the block being kept under a slight positive pressure to ensure freedom from similar contamination. These precautions have been taken because in the atmosphere of South Kensington a freshly sheared mineral surface receives sufficient hydrocarbon coating from the air in a minute or less to make its surface reactions quite unreliable. Under the new air control, not only the materials being tested, but also the reagents and apparatus, remain chemically clean for reasonably long periods.

During the 'at home', some standard ore-dressing operations were demonstrated, either on a miniature scale or as pilot-sized operations such as are conducted in commercial plants. Exhibits were also arranged to show something of the research work now under way in the special laboratories. These included the use of supersonic waves to influence sorption-rate from the water phase through the zeta-zone to immersed mineral surfaces; pressure-leaching as a hydro-metallurgical method of direct extraction of metals in the form of soluble salts; sub-sieve sizing by sedimentation and elutriation; radiotracer equipment to be used with fatty acids in the study of sorption phenomena at mineral surfaces; identification of minute quantities of unknown minerals by a combination of selective separation and micro-chemistry; thin section radiography for micro-examination of minerals and mill products; a motor-driven stage and counting machine for quantitative assessment of particle types under the

microscope; and a comparatively new method of testing the surface condition of small particles. Although the operations shown were limited by considerations of suitability for rapid demonstration as well as by the fact that the research work is only now settling down in its new home, it is clear that a wide field of scientific investigation has yet to be surveyed in terms of the special requirements of the mineral industry, and that measures have been taken to correlate this work with its commercial utilization. In this connexion, the traditional policy of making suitable provision for industrial ore-testing at the Royal School of Mines has been retained, so far as considerations of space and staffing permit.

One overriding justification for the new degree course and its allied activities

is the shortage of suitably trained mineral-dressing engineers. This dearth has proved a restrictive factor in the development of the large low-grade deposits on which modern industry increasingly depends, and is felt in every part of the world. During the next few years the Mineral Dressing Section of the Royal School of Mines expects to meet part of this need by giving accelerated training to postgraduate students; but it is felt that the long-term answer involves a steady increase in the number of graduates specially trained in this subject. Since much of the work can be done in the mill laboratory under pleasant, interesting and clean conditions it is not proposed to restrict intake to men only, though all those entering must be prepared to spend the first few years of their working careers outside Great Britain.

E. J. PRYOR

OBITUARIES

Lady Robinson

THE death of Gertrude Maud Robinson, wife of Sir Robert Robinson, Waynflete professor of organic chemistry in the University of Oxford, came as a profound shock to chemists throughout the world, and in particular to those in many universities who have been privileged to know her. Her contributions to chemical knowledge have been substantial in spite of many pressing calls on her time and energy. With characteristic enthusiasm she was working in the laboratory a few days before her death, and it is in the dual role of an indefatigable research worker and a kindly hostess that she will long be remembered. In particular, the younger members of the teaching staffs and their wives have reason to be profoundly grateful to her; she found time to take a personal interest in them and their families, which lasted long after they moved elsewhere. One other aspect of her

devoted life must also be mentioned. To her must be due in no small measure the unique position which Sir Robert holds to-day among the chemists of the world.

On January 21 of this year, Lady Robinson's contributions, direct and indirect, to organic chemistry were recognized by the award of the honorary degree of Master of Arts of the University of Oxford, a gesture which warmed the hearts of chemists everywhere.

Lady Robinson's scientific papers, mainly in the *Journal of the Chemical Society*, record work carried out in the Universities of Manchester, Sydney, Liverpool, St. Andrews, London (University College), and the Dyson Perrins Laboratory, Oxford. The first two, with Dr. C. Weismann, were published in 1910 and 1911 under her maiden name of Walsh. Many of the later papers were published jointly with Sir Robert Robinson. In work on certain derivatives of catechol ethers, the important discovery was made that asymmetrical substitution occurred in azoxy compounds, thus adding proof to that earlier provided by Angeli of the asymmetrical structure of the azoxy compounds themselves. Another series of papers of considerable novelty dealt with nitrogenous pseudo-bases, and the mechanism of Fischer's indole synthesis. Still another series described the development of new methods for the synthesis of high-molecular weight fatty acids, notable among which was a variation of the acetacetic ester synthesis for the extension of the carbon chain by twelve carbon atoms at a time; this elegant process culminated in the synthesis of *n*-triacontanoic in 1934.

Lady Robinson published numerous papers on the anthocyanins and their separation by distribution between two partially miscible solvents, a method which was virtually a forerunner of modern partition chromatography. More recently still, her interest in these compounds led her to undertake a very difficult task, namely, the investigation of the leucoanthocyanins, in particular peltogynol. She took an active part in the work on penicillin during the Second World War, and it is perhaps not generally known that she was the first chemist to prepare synthetical material with genuine antibiotic character of the penicillin type.

Lady Robinson's name is assured of a lasting and honoured place among those organic chemists who have made major contributions to their science.

W. BAKER

Prof. E. Esclançon

We regret to record the death on January 28 of M. Ernest Esclançon, the *doyen* of French astronomers, at the age of seventy-seven.

Esclançon started astronomical work at Bordeaux in 1899, taking a regular share in the routine work of the Observatory, observing minor planets and comets and making observations with the meridian circle and equatorial. But although he remained throughout his life associated with observatories, his principal achievements were not in astronomy, apart from administrative work. While still at Bordeaux he carried out gravity determinations in south-west France, relative to the standard at Paris. After the outbreak of war in 1914, he assisted in the geographic service of the French Army, doing work on sound-ranging and making a study of the sound waves resulting from the firing of a gun and the passage of a shell through the air. Towards the end of the First World War he took part in researches concerning submarines.

In 1919 Esclançon was appointed director of the Observatory at Strasbourg, which had been taken over from the Germans. Here he had the opportunity of publishing the work he had done during the War and of extending his researches to such subjects as the zones of silence at various distances from explosions, the rotation of projectiles around their centre of gravity, and the tides. He was so successful in building up an effective observatory at Strasbourg that when Deslandres retired from the directorship of the Observatories of Paris and Meudon in 1929, he was appointed to this important post.

Esclançon was always interested in the time service in which Paris has for long played an important part. He developed methods for the synchronization of pendulums electrically, and he introduced the speaking clock which latterly gave accurate time signals to 16 million Parisians annually. After acting as host for the general assembly of the International Astronomical Union at Paris in 1935, he was elected president of that Union for the next three years, terminating with the congress at Stockholm in 1938. He was president of the Paris Academy of Sciences in 1942, and finally retired in 1946. His services to astronomy were recognized in Great Britain by his election as an Associate of the Royal Astronomical Society in 1932.

J. JACKSON

NEW FELLOWS OF THE ROYAL SOCIETY

At the meeting of the Royal Society on March 18, the following were elected to fellowship:

PROF. D. H. R. BARTON, professor of organic chemistry, Birkbeck College, London, distinguished for his fundamental contributions to the chemistry and stereochemistry of terpenes, triterpenes and steroids.

PROF. T. MACF. CHERRY, professor of mathematics, University of Melbourne, distinguished for his researches on transonic flow and for earlier work on orbits in celestial mechanics.

PROF. E. G. COX, professor of inorganic and physical chemistry, University of Leeds, distinguished for his contributions to stereochemical problems in inorganic and organic chemistry by the application of X-ray crystallographic methods.

DR. F. O. FRANK, reader in physics, University of Bristol, distinguished for his original contributions to theories of crystal growth, of plastic deformation and of dislocations in crystalline solids.

PROF. A. B. HILL, professor of medical statistics, University of London, distinguished for his work on the application of statistical methods to medical problems, including the evaluation of new therapeutic and prophylactic drugs.

PROF. E. S. HILLS, professor of geology and mineralogy, University of Melbourne, distinguished for contributions to palaeontology, particularly of Devonian and Tertiary faunas, and for geological studies in Australia.

SIR CHRISTOPHER HINTON, managing director, Industrial Group, Department of Atomic Energy,

distinguished as an engineer who, by his leadership and by direct contributions, has played a major part in the development of large production plants in the British Atomic Energy Project.

PROF. F. E. KING, professor of chemistry, University of Nottingham, distinguished for his original contributions to synthetic organic chemistry, and for his investigations on wood extractives.

DR. H. G. KUHN, lecturer in physics, University of Oxford, distinguished for his development of delicate interferometric techniques, his work ranging from the study of continuous spectra to the examination of hyperfine structure.

DR. H. W. LISSMANN, assistant director of research, Department of Zoology, University of Cambridge, distinguished for his researches on animal behaviour, including the demonstration of a new form of sensory activity in animals.

PROF. F. C. MACINTOSH, professor of physiology, McGill University, Montreal, distinguished for his researches in the physiology and pharmacology of the central and peripheral nervous system, and for methods of biological assay.

DR. L. HARRISON MATTHEWS, director, Zoological Society of London, distinguished for his work on the physiology of reproduction.

J. L. PAWSEY, assistant-chief, Radiophysics Division, Commonwealth Scientific and Industrial Research Organization, Sydney, distinguished for his contributions to techniques of radio and radar, and in particular for his applications of these techniques to radio astronomy and to the study of the ionosphere.

DR. M. F. PERUTZ, lecturer in biophysics, University of Cambridge, distinguished for his elucidation of the structure of complex protein molecules by X-ray diffraction methods; for his detailed study of the structure and properties of haemoglobin; and for his investigations of the structure, deformation and flow of glacier ice.

PROF. A. J. S. PIPPARD, professor of civil engineering, Imperial College of Science and Technology, London, distinguished for his theoretical and experimental contributions to the theory of structures.

DR. ROSALIND V. PITT-RIVERS, biochemist, National Institute for Medical Research, London, responsible for notable advances in the biochemistry of the thyroid gland.

PROF. R. D. PRESTON, professor of plant biophysics, University of Leeds, distinguished for his investigation of the fine structure of plant cell walls.

DR. J. W. S. PRINGLE, lecturer in zoology, University of Cambridge, distinguished for his researches on neuromuscular co-ordination and the mechanism of equilibration in insects.

F. J. RICHARDS, senior principal scientific officer, Research Institute in Plant Physiology, Imperial College of Science and Technology, London, distinguished for his researches on the effects of mineral deficiencies and for his work on developmental morphology in plants.

PROF. C. RIMINGTON, professor of chemical pathology, University College Hospital Medical School, London, distinguished for his work on the biosynthesis of porphyrins.

PROF. W. W. ROGOSINSKI, professor of pure mathematics, University of Durham, distinguished for his contributions to mathematical analysis, particularly in the theory of functions and the theory of series, especially Fourier series.

DR. F. SANGER, biochemist, Medical Research Council, Cambridge, distinguished for his studies on protein structure, especially that of insulin.

PROF. H. G. THODE, head of the Chemistry Department, McMaster University, Hamilton, Ontario, distinguished for improvements in the technique of mass spectrometry and for the application of mass-spectrometric methods to problems in nuclear physics, chemistry and geochemistry.

DR. W. A. WATERS, lecturer in organic chemistry, University of Oxford, distinguished for his researches into the mechanism of organic reactions, especially those involving free radicals.

DR. C. B. WILLIAMS, head of the Department of Entomology, Rothamsted Experimental Station, distinguished for his pioneer work on migration of Lepidoptera and his studies of insect populations.

NEWS and VIEWS

Physics at Cardiff:

Prof. R. T. Dunbar

PROF. R. T. DUNBAR, who retires this summer from the chair of physics in University College, Cardiff, has been associated with the Physics Department at Cardiff for the past thirty years. Following a period of teaching and research at Edinburgh with the late Prof. C. G. Barkla, he was in 1924 appointed lecturer and director of the Viriamu Jones Research Laboratory, Cardiff, and held this position under both Prof. A. L. Selby and Prof. H. R. Robinson. It was during this period that he was able finally to dispose of Barkla's proposed *J* phenomenon. The planning and equipping of the new Tatem Laboratories in Cathays Park, Cardiff, which were then begun, were entrusted to him. Since 1930, when he succeeded to the chair, Prof. Dunbar has devoted himself to the needs of his students and to the increasing demands of a growing Department. During the years of economic depression between two World

Wars and again during the Second World War, the capacity of the new laboratories was fully taxed, so that the accommodation has recently had to be extended once more. The present facilities and equipment of his own Department testify to his vision and energies, but the rest of the College, too, has benefited much from his personal and detailed interest in all aspects of its growth.

Prof. A. J. C. Wilson

PROF. A. J. C. WILSON, who succeeds Prof. Dunbar, has had a distinguished record as an X-ray crystallographer. From Dalhousie University, Nova Scotia, and the Massachusetts Institute of Technology, he went in 1938 to the Cavendish Laboratory, Cambridge, as an 1851 Exhibitioner, and quickly showed an exceptional ability in both experimental and theoretical work. He carried out some beautiful work on the measurement of coefficients of expansion of

metals by X-ray diffraction, but it was apparent that his theoretical ability was his greater gift, and he made several important fundamental contributions to the theory of the diffraction of X-rays by crystals; his work on diffraction by imperfect crystals is likely to remain standard for a long time. He was quick to realize the importance of apparently trivial observations, and a chance remark by one of his colleagues at Cambridge set him thinking along a new line—the distribution of intensity in the different orders of diffraction from a single crystal. Unable to proceed far with this subject during the war years, he took it up seriously upon his appointment as senior lecturer at Cardiff, and, with several of his colleagues, he published a series of papers which have revolutionized ideas about the determination of space groups. The methods described have already proved extremely useful in many crystal-structure determinations. Prof. Wilson has also shown himself to be an extremely able administrator, his work on editing "Structure Reports" and producing data for the "A.S.T.M. Index" alone putting the world of X-ray diffractionists greatly in his debt.

Pharmacology and Therapeutics at Sheffield:

Dr. G. M. Wilson

PROF. E. J. WAYNE is resigning at the end of this month from his post as professor of pharmacology and therapeutics in the University of Sheffield, in order to take up the chair in the practice of medicine in the University of Glasgow, and will be succeeded by Dr. G. M. Wilson, at present lecturer in therapeutics in the University of Sheffield. Dr. Wilson was educated at the Edinburgh Academy and the University of Edinburgh, qualifying as a medical practitioner in 1940. During 1941–46 he served in the Medical Branch of the Royal Air Force, becoming officer in charge of the Medical Division of No. 6 R.A.F. General Hospital, Cairo, and medical specialist to the R.A.F. Middle East Command Medical Board. After demobilization, he was appointed an assistant to the Medical Unit of St. Mary's Hospital, London. He went to the University of Sheffield in 1950 as lecturer in therapeutics and a year later was appointed senior lecturer in therapeutics and a consultant physician to the United Sheffield Hospitals. He spent the academic year 1952–53 at Harvard University on an Eli Lilly travelling fellowship in medicine of the Medical Research Council. Since the War, Dr. Wilson has carried out a series of studies of some disorders of the peripheral circulation, and he has recently been studying the part played by the endocrine system in the development of metabolic and cardiovascular disturbances.

Statistics in the University of Aberdeen

THE University of Aberdeen is creating the new post of reader in statistics as from October 1, 1954. Dr. D. J. Finney, lecturer in the design and analysis of scientific experiments in the University of Oxford, will be the first holder of this readership. Dr. Finney will be in charge of teaching and research in this Department of Statistics, in which new developments, including the provision of increased statistical services for other University departments, are under consideration. The Agricultural Research Council is simultaneously establishing a new Unit, the Unit of Statistics, within the University of Aberdeen. Dr. Finney will be the director of this Unit, and in this capacity will collaborate with Agricultural Research Council institutes in Scotland and assist in the design

and analysis of their experiments. Dr. Finney's advice will also be available to other institutes and organizations concerned with agricultural research in Scotland. In addition, the Unit of Statistics will be responsible for carrying out specific investigations on behalf of the Council. The University Department of Statistics and the Agricultural Research Council's Unit will be housed in Marischal College, Aberdeen.

Royal Geographical Society: Awards for 1954

H.M. THE QUEEN has approved the award by the Royal Geographical Society of the following Royal Medals: *Founder's Medal*, to Brigadier Sir John Hunt, leader of the British Mount Everest Expedition; *Patron's Medal*, to Dr. N. A. Mackintosh, deputy director of the National Institute of Oceanography, for research and exploration in the Southern Ocean since 1924, with special reference to his voyages in the *Discovery II* during 1929–31 and 1933–35. The Council has made the following awards: *Murchison Grant*, to G. R. Crone, librarian and map curator of the Royal Geographical Society, for contributions to the history of cartography and to the history of geography; *Bage Grant*, to Commander G. S. Ritchie, of the Hydrographic Department of the Admiralty, for his contribution to oceanographical exploration as commanding officer of H.M.S. *Challenger* during 1950–51; *Cuthbert Peck Grant*, to Dr. T. E. Armstrong, of the Scott Polar Research Institute, University of Cambridge, for studies in the history and economic development of the Arctic, with special reference to the northern sea route; *Gill Memorial*, to Dr. W. G. V. Balchin, lecturer in geography, King's College, London, for contributions to geomorphological and geographical research; and *Mrs. Patrick Ness Award*, to C. W. M. Swithinbank, Pembroke College, Oxford, formerly a member of the Norwegian-British-Swedish Antarctic Expedition, 1949–52, for research in antarctic glaciology.

British Welding Journal

WITH the co-operation of the Institute of Welding and of the British Welding Research Association, a new monthly periodical, the *British Welding Journal*, has been started, and the first part has just been published (2 Buckingham Palace Gardens, London, S.W.1. Members, free; non-members, 10s.). As Dr. J. H. Paterson, a past president of the Institute of Welding, remarks, "when it is considered that the first practical applications of the welding of metals on any considerable scale are not much more than sixty years old, it is remarkable how rapidly this process has attained its present proportions". All aspects of the subject are undergoing intensive scientific and technical investigation, and it is to provide a unified avenue of publication for such work that the new *Journal* is primarily intended. This combination of the proceedings of the Institute of Welding, in the main practical in character, and the scientific reports of the Welding Research Association, together with reviews of current literature, should, in the words of Sir William Larkie, "make available to the technologist the results of research, so that they can be translated into practice; and bring to the knowledge of the research worker the difficulties which arise in their practical application". Among the papers contained in this first issue are the following: a most interesting historical account dealing with the development of

metal-arc welding and electrodes during the past half-century; welding as a career; the welded structure in a pump-house foundation; the effect of steel quality on spot-welding properties; and the use of self-adjusting arc equipment for welding a light-alloy deckhouse. The presentation of the *Journal* is excellent, permitting photomicrographs to be reproduced with admirable clarity. It should perform a most valuable function in a sphere of metallurgy and engineering which is bringing about a revolutionary change in the constructional field.

A Systemic Rust Fungus

WHEN the uredospores of the autoecious rust *Puccinia suaveolens* attack the creeping thistle *Cirsium arvense*, isolated uredo-pustules, usually with some teleutospores, are formed (B. P. Manziac, *Ann. Bot.*, N.S., 17, 68 and 551; 1953). The mycelium later grows down into the roots and becomes systemio. In some of the root-buds the mycelium appears unchanged and bears uredosori; in others it undergoes a somatic segregation of mating type and bears spermogonia only. Teleutospore germination is so erratic that basidiospore infection is responsible for only a small amount of the spermogonial infection observed. The spermogonial mycelium in the systemically infected shoots is heterothallic, and there are two mating types. All the spermogonia on one shoot bear spermatia of only one mating type. Therefore, segregation of mating type must take place at the base of the shoot or even in the roots. The multinucleate condition of the mycelium in both uredosoral and spermogonial shoots makes it impossible to observe segregation directly.

Common Marine Bivalves of California

A GUIDE to some sixty species of Californian lamellibranch molluscs of economic importance has been compiled by John E. Fitch and published under the title "Common Marine Bivalves of California" (Fish Bulletin No. 90 of the Department of Fish and Game, State of California; pp. 102; San Francisco, 1953). The first twenty pages contain general information on nomenclature, habits, structure and reproduction of marine bivalves, and also give methods of collecting, culturing and preparing edible species. Then follows a key for identification of the species, with diagrams to illustrate technical terms. The main section comprises descriptions of the species, a page being allotted to each. A photograph of the outside of the shell is given; but only in the piddocks and gapers are the siphons shown. A brief description of distinguishing characters is accompanied by notes on the range of each species in California, its habits and economic use. A number of species of no economic value, but which may be taken when searching for food or bait, are included. The author has made an attempt to standardize the names by which the commoner bivalves are known, and has found it necessary to change some to accord with their phylogenetic relationships. The style of this pamphlet is clear and concise, and the black-and-white photographs are excellent. Although intended for the amateur naturalist or clam digger, this work has considerable scientific value. The method of presentation might well form a basis for other publications of a similar nature.

University of Leeds: Gifts to Departments

GIFTS made to various departments in the University of Leeds include the following: to the

Department of Physical Chemistry, £700 from the Anglo-Iranian Oil Co., Ltd., for research, and 5,000 dollars from the Rockefeller Foundation for research in radiation chemistry under the direction of Prof. F. S. Danton; to the Department of Textile Industries, £250 from the Anglo-Iranian Oil Co., Ltd., for research; to the Department of Civil Engineering, £500 from the Cement and Concrete Association for scholarships and £200 a year (plus income tax) for seven years from Wm. Airey and Son (Leeds), Ltd., for scholarships in concrete technology; and to the Department of Colour Chemistry and Dyeing, £5,000 from the British Silk Dyeing Co., Ltd., Balloch, Alexandria, Scotland, for research.

Department of Scientific and Industrial Research: Grants to Research Workers and Students

THE Department of Scientific and Industrial Research is offering three types of grants to British research workers and students normally resident in Great Britain: maintenance allowances (approved fees plus £245-325) to postgraduate students for a year's full-time training in the methods of scientific research; senior research awards (maximum of £600 a year) for postgraduate research; and grants for special researches to enable investigators to obtain scientific, laboratory or clerical assistance or to purchase special equipment, materials or services not normally provided by a university for scientific purposes. Generally speaking, candidates for maintenance allowances or senior research awards should not be more than twenty-seven years of age. All the awards are tenable in universities, colleges, establishments of the Department of Scientific and Industrial Research, research association laboratories and other institutions approved by the Advisory Council for Scientific and Industrial Research. The closing date for applications for maintenance allowances is April 15 and for the other awards April 1. Further information is available in a pamphlet, "Notes on D.S.I.R. Grants to Research Workers and Students" (price 6d.), obtainable from the Department at Charles House, 5-11 Regent Street, London, S.W.1.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: J. R. Antoine (assistant plant pathologist, Mauritius), senior agricultural officer, Mauritius; P. O. Chambers (director of agriculture, Cyprus), director of agriculture, Northern Region, Nigeria; M. Robson (conservator of forests, Nigeria), chief conservator of forests, Western Region, Nigeria; I. Langdale-Brown, botanist, Uganda; J. P. T. Boorman, scientific officer (entomologist), Nigeria; D. N. F. Hall and J. H. Wickstead, scientific officers (fisheries), Singapore; F. H. Talbot, scientific officer, East Africa High Commission; P. J. Larkin, veterinary officer, Kenya; P. A. L. Wight, veterinary officer, Nyasaland; E. F. W. O. Brunig, assistant conservator of forests, Sarawak; N. W. Neal, veterinary officer, Uganda; J. Nicholls, livestock officer, Nyasaland; F. S. Peritz, veterinary officer, Local Civil Service, Gold Coast; J. F. Redhead, assistant conservator of forests, Nigeria; J. M. A. Sly, scientific officer (agronomist), Nigeria; S. R. Smithers, scientific officer, Gambia; H. A. W. Southon, scientific officer (entomologist), East Africa Tsetse and Trypanosomiasis Research and Reclamation Organization, East Africa High Commission; L. G. Stephens, veterinary officer, Hong Kong;

S. L. Wanrooy, tobacco-growing expert, British Honduras.

The Night Sky in April

NEW moon occurs on April 8d. 12h. 25m., U.T., and full moon on April 18d. 05h. 48m. The following conjunctions with the moon take place: April 1d. 18h., Mercury 7° S.; April 4d. 18h., Venus 6° S.; April 8d. 03h., Jupiter 3° S.; April 19d. 05h., Saturn 8° N.; April 23d. 17h., Mars 1° N. Mercury is too close to the sun for favourable observation during the month. Venus, an evening star, rises at 19h. 50m., 20h. 35m. and 21h. 20m. on April 1, 15 and 30, respectively, the stellar magnitude of the planet varying between 3.4 and 3.3 and the visible portion of the illuminated disk between 0.967 and 0.929. Mars rises at 1h. 15m., 0h. 50m. and 0h. 10m. at the beginning, middle and end of the month, respectively; its eastward movement during April carries it a little north of λ Sagittarii towards the end of the month, and its stellar magnitude varies from 0.1 to -0.6, the great increase in brightness being largely due to its approach to the earth, from 89 to 66 million miles during April. Jupiter sets at 0h. 50m., 0h. and 23h. 15m. on April 1, 15 and 30, respectively, its stellar magnitude varying from -1.7 to -1.6; its slow eastward movement from the west to the east of ζ Tauri can be easily seen during the month. Saturn rises at 20h. 50m., 19h. 50m. and 18h. 40m. on April 1, 15 and 30, respectively, and is easily recognized, stellar magnitude 0.4, a little east of $\times$ Virginis. Occultations of stars brighter than magnitude 6 are as follows, observations being assumed to be made at Greenwich: April 6d. 20h. 44.7 m., 36 Taur. (D); April 8d. 21h. 31.9 m., 5 Gemi. (D). D refers to disappearance. The Lyrid meteors, the debris of Comet 1861 I, are active during about April 20-23, but moonlight will interfere with their observation during the later part of the night.

Announcements

THE Council of the Linnean Society of London has nominated Prof. F. E. Fritsch, emeritus professor of botany in the University of London, for the award of the Linnean Gold Medal for 1954, and Prof. Irene Manion, professor of botany in the University of Leeds, for the Trail Award and Medal. The presentation will be made at the Anniversary Meeting on May 24.

THE Hinchley Medal of the British Association of Chemists has been awarded to Mr. George T. Gurr, an authority on stains for microscopical work and their manufacture and author of "Biological Staining Methods", who has been prominently connected with the Association for a number of years.

DR. A. R. J. P. URBELONDI, professor of chemistry in The Queen's University of Belfast, has been appointed to the University of London chair of thermodynamics tenable at the Imperial College of Science and Technology.

DR. B. P. DUDDING, vice-chairman of the Advisory Scientific Panel of the Research Laboratories of the General Electric Co., Ltd., has been made an "Ufficiale dell' Ordine al Merito della Repubblica Italiana", in recognition of his services to the Italian glass industry. Dr. Dudding has given long service to various bodies connected with glass and glass technology, both national and international, and was president

of the International Commission on Glass in July last year.

A FARADAY SOCIETY Discussion on "The Study of Fast Reactions" will be held during April 7-9 in the Department of Chemistry, University of Birmingham, under the chairmanship of the president of the Society, Prof. R. G. W. Norrish. The meeting will be in two parts, gas reactions and solution reactions, which will be given a general introduction by Prof. H. W. Melville (University of Birmingham) and Mr. R. P. Bell (University of Oxford), respectively. Further information can be obtained from the Secretary of the Society at 6 Gray's Inn Square, Gray's Inn, London, W.C.1.

THE Imperial College of Science and Technology will be holding a summer school in mineral dressing in the Bensham Laboratory, Royal School of Mines, Prince Consort Road, London, S.W.7 (see p. 585 of this issue), during September 14-17 (10 a.m.-5 p.m. each day). The course will include lectures covering comminution, classification, grinding control, gravity separation, flotation and ancillary processes and will be illustrated by films, demonstrations and class work. The fee for the course is £10 10s. Application forms can be obtained from the Registrar, Imperial College, Prince Consort Road, London, S.W.7.

THE conference on oxidation processes, arranged jointly by the Institution of Chemical Engineers, the Chemical Engineering Group of the Society of Chemical Industry, the Royal Institution of Engineers (Chemical Engineering Group) of the Netherlands and the Royal Netherlands Chemical Society (Section for Chemical Technology) (see *Nature*, February 6, p. 245), will not now be held in The Hague, as previously announced, but instead will be in Amsterdam during May 6-8 at the Royal Tropical Institute (Koninklijk Instituut voor de Tropen), Mauritskade 63.

THE Third General Assembly and International Congress of the International Union of Crystallography will be held in the Faculté des Sciences, 47 rue des Écoles, Paris 5^e, during July 21-23. Two symposia are being arranged to take place during the Congress: location and function of hydrogen, organized by Dr. W. Cochran, of the Cavendish Laboratory, Cambridge; and the mechanism of phase transitions in crystals, organized by Dr. W. G. Burgers, of the Technical Institute, 136 Julianalaan, Delft. Those intending to participate in either of these symposia should write before March 31 to the organizer and also to the secretary of the Congress, A. J. Rose, 1 rue Victor-Cousin, Paris 5^e, from whom all further information concerning the Congress can be obtained.

It is proposed to publish in the near future a new journal, to be entitled *Gwerin: an International Journal of Folk Life*, which will be devoted to papers, notes, reviews, etc., on all aspects of folk-life research in Great Britain and Ireland and their relations with the Continent of Europe (including Scandinavia). The language of the journal will be English. The general editor of the journal is Dr. Iorwerth C. Peate, curator of the Welsh Folk Museum, St. Fagans, near Cardiff. Two parts will be published each year, each being about sixty pages ($7\frac{1}{2} \times 9\frac{1}{2}$ in.), with plates, and costing 5s. 6d. post paid. All those wishing to subscribe to this new journal should write as soon as possible to Dr. Peate.

A NEW GYROSCOPIC INSTRUMENT

A NEW instrument known as the 'Gyrotron', which has been made by the Sperry-Gyroscopic Co., is an important step in aircraft instrumentation and is interesting in that it has been developed from observation of the flight-control methods of Diptera. J. W. S. Pringle was the first to give a fully satisfactory explanation of the mechanism and functions of the halteres of Diptera¹. These club-shaped lateral projections from the fly's thorax vibrate in a vertical plane through an angle of some 150° during horizontal flight, the motion having a constant amplitude and being maintained at the natural frequency of the system (Fig. 1). The large amplitude of this motion means that in the plan view the mass represented by the end knob of the haltere has a lateral in-and-out motion at twice the frequency of the oscillation of the haltere, since the knob moves inwards and outwards for the half-cycle while it is above the horizontal position, and again for the half-cycle while it is below this position. By reason of this in-and-out component of the motion, the fly is able to detect a yawing turn. If during flight the fly starts such a turn (about the vertical axis), forces, called Coriolis forces, are developed as a result of the combination of the turn with the motion described. These Coriolis forces also arise in gyroscopic apparatus and, as will be seen later, in the new type of 'vibratory gyro'.

The Diptera have sense organs at the base of the halteres which detect the action resulting from the Coriolis forces. These give a signal which enables the fly to correct the rotation and maintain a straight course—a task which experiment shows to be impossible for a fly from which the halteres have been removed.

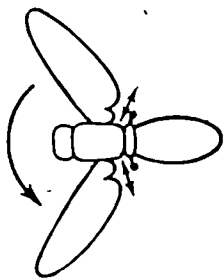


Fig. 1. Diagram illustrating movement of halteres

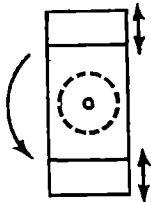


Fig. 2. Plan of vibrating tuning fork

The engineers developing the 'Gyrotron' had to produce an instrument sensitive to a very much slower rate of yawing rotation than the fly's halteres, and their success is indicated by the fact that they are able to measure rotations as slow as that of the earth. This is done by a rugged instrument which has a range of speed indication up to about a hundred revolutions per minute.

The basic detector unit of the 'Gyrotron' consists essentially of a tuning fork which is maintained in vibration, with constant amplitude, by an electromagnetic drive. This is used to detect a rotation about the axis of the 'handle' of the fork (Fig. 2). The tines oscillate inwards and outwards in a way that corresponds to the essential part of the motion of the halteres of a fly. This leaves the problem of detecting

the Coriolis forces generated when the fork is rotated about its axis.

Another way of expressing the Coriolis effect is to say that, as the tines oscillate, the moment of inertia of the fork about the handle axis varies periodically with the frequency of the vibration of the fork, and may be expressed by $I = I_0 + I_1 \sin \omega t$, where $\omega = 2\pi n$ is the frequency, I_0 is the moment of inertia of the fork when the tines are in the mean position, and I_1 represents the greatest departure from this mean. If a rotation, with constant angular velocity Ω about the handle axis, is given to the fork, the angular momentum about the axis is given by

$$V = \Omega (I_0 + I_1 \sin \omega t).$$

In order to maintain this rotation, the couple applied to the handle of the fork must be

$$L = dV/dt = I_1 \Omega \omega \cos \omega t.$$

It is this alternating couple that the instrument engineer must detect and measure. It corresponds exactly to the requirements of the sense organs at the roots of the halteres, except that the sense organs observe each haltere independently, while in the 'Gyrotron' the tines of the fork always move in unison so that the effect on the fork as a whole may be observed.

The basis of detection is to support the fork on a torsional spring of such stiffness that its natural frequency on the spring is also n . The fork then develops an oscillatory torsional motion just as though the couple L were being applied to it directly, thereby making use of the large dynamic magnification of the resonant system. What is actually measured, by a suitable pick-up, is the velocity associated with the oscillatory rotation, which is superimposed on the steady applied rotation Ω . Provision is made for electromagnetic damping of the motion, this being necessary when measuring higher angular velocities. The velocity of the oscillatory rotation gives a measure of the angular velocity Ω , and its phase, relative to the time motion, indicates the direction of Ω . The output signals are suitably combined to give a direct reading of angular velocity on a dial. A considerable amount of electronic equipment is, of course, used; but the whole instrument, including amplifiers, although only in the early stages of development, weighs less than 7 lb.

The development of this device as a normal rate-of-turn meter for aircraft is clearly an immediate possibility. It is at once more robust and more sensitive than the gyroscopic type currently in use. Future developments lead towards a directionally stable instrument (like a free gyroscope) and perhaps to a complete replacement of gyroscopic instruments—even the gyro-compass—by 'Gyrotron' types; for once it is possible to detect rotation in this way, it should ultimately be possible to maintain it at any desired value.

A. L. PERCIVAL

¹ Lyman, J., *Aeronaut. Eng. Rev.*, 12, No. 11 (1953).

² Pringle, J. W. S., *Phil. Trans. Roy. Soc., B*, 232, 247 (1943).

POWER FROM ATOMIC ENERGY*

ONLY when concentrated sources of energy—or fuels—were discovered did modern civilization become possible. While complete mechanical use of their energy is possible in principle, this has not yet been accomplished even with chemical fuels, and only 30–40 per cent utilization of the irreversible heats of reaction is possible. Nuclear fuels, a million times more concentrated than chemical fuels, are now becoming practically useful, and thermonuclear reactions—at present used only explosively—may enter the field eventually.

Nuclear reactors cannot be very small and are probably impracticable for vehicles and aircraft—though very promising for ships. Their greatest importance—now that breeding is possible in fast reactors—will be as sources of large-scale power. The cost cannot be predicted realistically, but it might eventually come down to that of power from coal—which, in any event, represents only a few per cent of the cost of industrial products.

The practical difficulties of nuclear power production are immense. Materials have to withstand radiation and high temperatures. Operation of plant must be largely by remote control, and the large-scale disposal of fission products will be difficult. Very careful planning is necessary for safety and economy—because plants are necessarily large. The designers of the prototype submarine reactor—though 'firmly optimistic' about the future—have emphasized these problems, which will become still more acute in power breeders.

Countries have greatly differing needs for nuclear-power projects. The United States will clearly continue development—for prestige reasons and because it can now afford to export plant. Canada must be interested because of her undeveloped northern regions. The U.S.S.R., which can probably benefit more than the United States, will also be influenced by considerations of prestige. Many small European countries have entered the field—at the risk of absorbing too much of their technology. Africa and other undeveloped countries need nuclear power vitally.

In Great Britain nuclear power could augment coal power substantially and its prospects must be carefully examined. Allowing for, say, three generations of reactors during development and assuming an expenditure comparable to the present expenditure on new electrical generating plant, it would be approaching the end of the century before the present production of electricity from coal could be equalled. But by this date Britain ought to have increased power production about five times to compete industrially with the United States. Since only one-sixth of her coal is used to produce electricity in Britain, there is clearly no prospect of substantially reducing the consumption of coal, and a much greater effort should be devoted to fuel-saving.

At the same time, Britain has a unique opportunity of regaining her economic balance by exporting nuclear power plant to other countries. Such a project would require full industrial participation and a real national effort to increase scientific manpower and use of science, and to reduce waste.

* Summary of a lecture by Prof. F. H. Simon, O.B.E., F.R.S., being the third of the series of public lectures arranged by the Atomic Scientists' Association and the Department of Extra-Mural Studies of the University of London (see also *Nature* of February 27, p. 286, and March 13, p. 477).

Among British assets are brain-power and freedom from the crippling 'spy-hunt' atmosphere, and atomic energy could have a decisive influence on Britain's future. But those who think this will come without effort are mistaken.

GROUND-WAVE PROPAGATION AT ULTRA-HIGH FREQUENCIES

THE general trend of development of television and other radio services to increasingly higher frequencies emphasizes the need for more detailed knowledge of the characteristics of wave propagation over the ground at such frequencies. Two papers of interest in this connexion were read before the Radio Section of the Institution of Electrical Engineers on February 10.

The first paper, by Dr. J. A. Saxton and B. N. Harden, described the results of an experimental investigation of the effects of irregular terrain on ground-wave propagation at frequencies of 102.6 and 593.6 Mc/s. Particular attention was paid to the work at the higher frequency, which is midway between the bands, known as IV (470–585 Mc/s.) and V (610–960 Mc/s.), allocated for the future development of television in Great Britain.

With the aid of an experimental transmitter set up first at the Radio Research Station, Slough, on a mast 28 m. high and 40 m. above sea-level, and later at the B.B.C. station at Sutton Coldfield, from a mast at a height of 184 m. above ground and 365 m. above sea-level, measurements of received field strength were made in various directions out to distances of nearly 100 km. Within this range, variations of field strength arising from changes in atmospheric refraction sometimes occur, but they are of little significance compared with the effects of the terrain, which result in relatively large changes in strength for different directions of transmission or for small displacements in the actual location of the receiver. Having in mind the irregular nature of the ground over which the propagation must be studied, the results of the variation of field strength with distance must be presented on a statistical basis. Thus it was found that at the lower of the two frequencies used (near 100 Mc/s.) the relation between median field strength and distance agreed fairly closely with the theoretical values calculated for transmission over a smooth earth. At the higher frequency (near 600 Mc/s.), however, it was found that the median field strength at a distance of 70–80 km. may be as much as 20 db. below that estimated for smooth-earth conditions. Moreover, it was found that, with a receiving aerial at the usual height of about 9 m., considerable further attenuation may be experienced in heavily built-up areas. A fairly wide range of variation of field strength may also occur over a small range at any particular receiving site, in extreme cases amounting to 20–25 db. This experience indicates that considerable care may be needed in the choice of position of a receiving aerial when television transmission takes place at wave-lengths corresponding to one or two feet.

In the second paper, Dr. J. A. Saxton has collected information of the type described above, together with the results of similar investigations conducted in the United States, so as to compare the experi-

mental data for ground-wave propagation at frequencies between 50 and 800 Mc./s. with the corresponding conditions for transmission over a smooth earth. The graphs accompanying the paper show that, whereas for given transmitter conditions the field strength at a given distance over a smooth earth increases with the frequency, this effect is more than counterbalanced by the effect of the irregular terrain under conditions realized in practice. Thus, at the lower end of the frequency band (50–70 Mc./s.) there is little difference between median field strengths observed over irregular terrain and those calculated on the assumption that the earth is smooth. As the frequency is increased above 70 Mc./s., the observed median field strength falls more and more below the ideal theoretical values, the difference being as much as 20 db. at 700 Mc./s. The experimental work thus makes it possible to provide a simple empirical modification to the ideal smooth-earth propagation characteristics which will give the median field strengths to be expected over irregular terrain.

The discussion which followed the presentation of these papers showed that the conclusions are of considerable interest and importance to those who will be responsible for the development of future television and communication services at these higher radio frequencies.

SCIENTIFIC APPRAISAL OF SINGING VOICES

By DR. FRITZ WINCKEL

Institut für Schwingungsforschung, Technische Universität, Berlin-Charlottenburg

WHILE it has long been possible to describe exactly the 'spectrum' of voices in speech, no detailed knowledge has hitherto been available about the spectrum of the trained singing voice, especially the timbre. In earlier investigations, the physical conditions were not exactly defined¹, and in particular the analyses made from normal records led to doubtful conclusions². We have tested a considerable number of voices of well-known singers by electro-acoustic means, in order to obtain a better knowledge of the physical properties of trained singing voices. If, say, a singer is singing in a medium pitch of about 300 c./s. in mezzo-forte, about ten partial tones are present. Each of these can be co-ordinated with a particular vowel quality and have a greater or less share in the full sound, depending upon the type of text, the pitch and the quality of the singing voice. By analogy with optics, these partial tones can be termed 'vowel colour' (*Vokalfarbe*). Thus the timbre of a trained singing voice can be distinguished from the 'flat' voice of an untrained singer by the fact that all vowel colours are available simultaneously in a certain modulation of intensity. Physically, the character of a good singing voice consists of the most favourable mixture of these vowel colours forming a 'complex colour' (*Komplexfarbe*). There are other features of importance; for example, a nasalizing region around about 2,000 c./s. (the so-called *Nasalformant*) and a carrying region of about 3,000 c./s., which is thought to correspond to the active radius of the singing voice. In addition, there are other frequency regions which can be defined as 'metallic', 'hollow', 'sharp', etc.³.

In a studio which is damped to the utmost, singers have a more pithy voice than in a resounding hall. This is explained by the fact that in a damped studio the trained functions are more active, since unfavourable auto-suggestive influences through the ear and the central nervous system of the singer are avoided.

When testing singers' voices, the 'dynamic volume' has been measured by means of sound energy meters and an individual sound energy-level determined, a factor which has hitherto been overlooked by other investigators, leading to questionable results.

Deviations from the characteristic frequency properties of the singing voice indicate vocal disease or affections of the respiration organs. In co-operation with physicians a practical diagnostic method by analysis of microphone recordings has been worked out for application by ear, nose and throat specialists.

As a result of these investigations, the Technical University of Berlin-Charlottenburg has established a centre for voice estimation and training, to serve the purposes of teachers of singing and physicians. Magnetophone recordings of voices can be sent in for analysis; and the singer or patient receives a sound spectrum with an explanatory note. Such analyses have the documentary value of an X-ray photograph or electro-cardiogram.

A special instrument, called a 'repeater' (*Repeatergerät*), has been developed by the Institute of Wave Research for the analysis of singing voices. The singer needs only to sing notes of short duration, which are lengthened by the repeater to continuous notes for analysis. Another important use of the repeater is in teaching. In the course of a considerable period of experiment, the Institute has tested in particular coloratura voices, by means of continual repetition of particular passages of the recording, for the qualities of 'attack', intonation, etc. This 'listening-in' to extracts of note sequences has often helped a student of singing to achieve a remarkable improvement in performance.

¹ Stanley, Douglas, "The Science of Voice" (Carl Fischer, New York, 1939).

² McGinnis, O. S., Hinck, M., and Kraichmann, M., *J. Acoust. Soc. Amer.*, **23**, 440 (1951).

³ Detailed information is given in *Folia phoniatrica*, **4**, No. 2, 93 (1952); **6**, No. 1 (1954).

SCIENCE AND MODERN COSMOLOGY

PROF. H. DINGLE delivered on February 18, 1953, his retiring presidential address to the Royal Astronomical Society, selecting "Science and Cosmology" as his subject, and the full text has now been published (*Mon. Not. Roy. Astro. Soc.*, **113**, 3; 1953). Prof. Dingle pointed out that in the earlier stages of science the world was so full of mysterious phenomena that there was no temptation to go outside experience in search of other realms; in addition, it became almost an intuition with scientists that at every stage they must submit their findings to the test of observation. While science then incurred little danger of violating its own principles, unfortunately this state of affairs does not always exist to-day, and in the realm of cosmology it has almost completely disappeared. The universe is no longer the observable world that was once the sole

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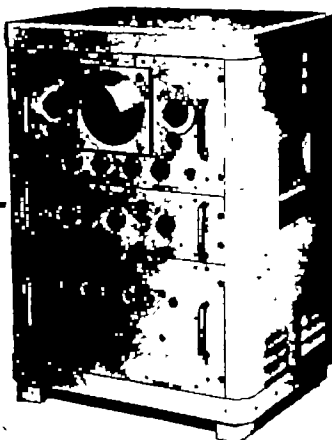
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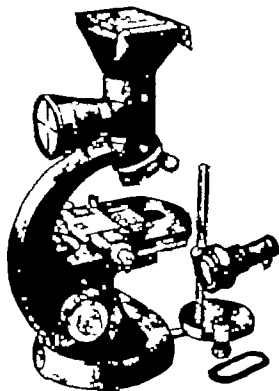
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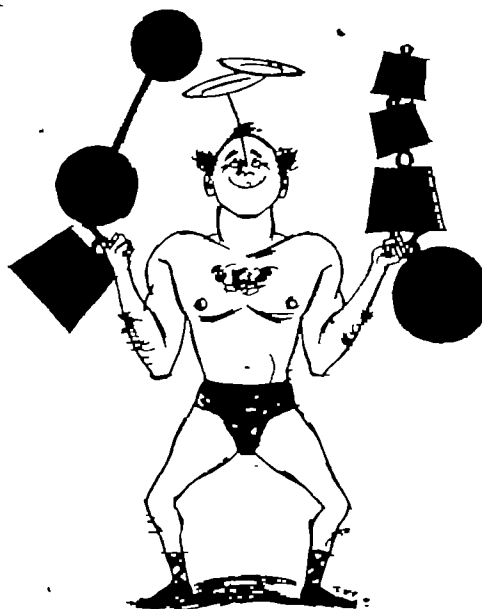


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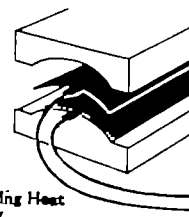
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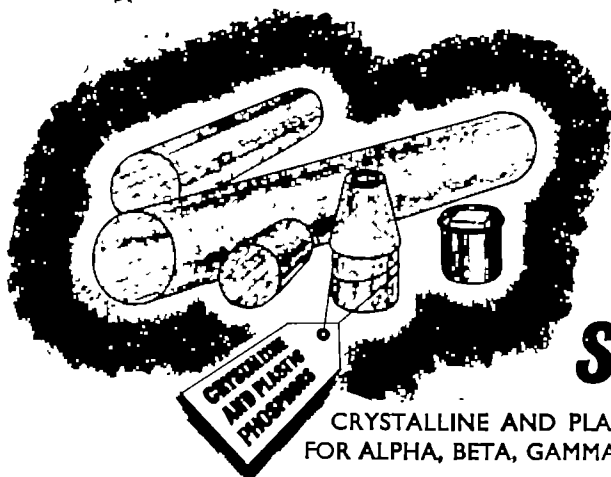
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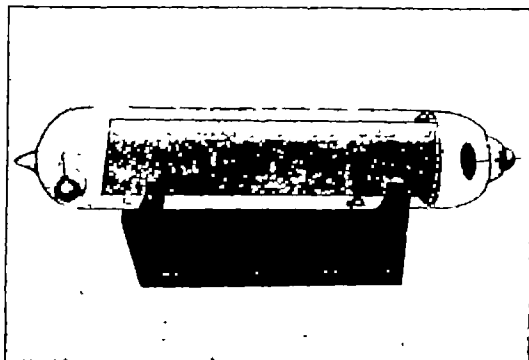
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object of astronomical study; on the contrary, it is, he said, "a hypothetical entity of which what we can observe is an almost negligible part". Assertions now made about it require observations over the remote past or over millions of years in the future, if they are susceptible of test at all, and hence speculation is inevitable; only strict adherence to the essential principles of science can control such speculations, and in cosmological studies a knowledge of the history and philosophy of science is most essential.

Prof. Dingle commented on a number of recent speculations by some cosmologists. Thus it has been stated that it is against the spirit of scientific inquiry to regard observable effects as arising from causes unknown to science, and that in principle this is what creation-in-the-past implies. Prof. Dingle said that confession of ignorance, far from being unscientific, is a characteristic of the scientific attitude, in support of which quotations are available from the works of Galileo and Newton. Perhaps the most extraordinary thing about the second statement, he continued, is that this idea of the creation of matter is just that which is opposed to the spirit of scientific inquiry—that the observable universe was created in the past by causes unknown to science.

Another statement claimed by Prof. Dingle to be fallacious is connected with an underlying assumption in experimental science; this assumption is that the repetition of an experiment will reproduce the original results. But experimental science is not based on an assumption; "it is an adventure in which you accept whatever you find, and although you may be guided in a particular case by an expectation, the experiment may reveal something totally different". An instance of this is found in the case of Schwabe, who counted sunspots with the object of finding an intra-Mercurial planet, and instead of doing so he found the eleven-year solar period. But if he had counted the spots with any other object or no object at all, he would still have found the eleven-year solar period; it would be futile to believe that the achievements of experimental science would necessarily lose all significance if it were discovered that some assumption proved baseless. In the realm of psychology it is accepted that no experiment when repeated produces the original result, and even in physics it has been held for a long time that no experiment is repeatable, the entropy of the universe never being twice the same.

A very severe criticism of 'the cosmological principle' and 'the perfect cosmological principle' advocated quite recently in some quarters was the next topic in Prof. Dingle's address. The evidence for these, he said, is practically non-existent, and he advocated a principle which, he thinks, will command universal assent: "No statement about the universe, or nature, or experience, or whatever term you prefer for the object of scientific investigation, shall be made . . . for which there is no evidence". At present we are faced with the rather disconcerting fact that any statement can be made about the universe if it cannot immediately be refuted; and if anyone is attracted by an idea for which there is no evidence, it is only necessary to call it a 'principle', no evidence being then required. When we are informed that matter is being continually created, but in such a way that the process is imperceptible, obviously the statement cannot be disproved; but

when we ask why it should be accepted, we are informed that the fundamental axiom of science requires it. To avoid using names which he considers misleading, Prof. Dingle referred to the 'cosmological principle' as the "cosmological assumption" and to the 'perfect cosmological principle' as the "cosmological presumption".

Holding, as he does, that the object of scientific investigation is the world of experience or even experience itself, and that all advances in science consist either in enlarging the range of experience or in expressing the regularities found or to be found in it, Prof. Dingle has no place for the new doctrine that experience must conform to the tastes of the investigator. Equally he completely rejects its twin doctrine that experience must conform to a pattern which we can deduce by pure reason. The usual form of this latter doctrine is that the laws of Nature can be derived by reason without recourse to experience, but those who hold this view overlook the important fact that, by definition, laws of Nature are laws followed by what we experience and not by what we deduce from our axioms. A remarkable position in cosmology, he said, is that two impostors have usurped the throne of science, one of which is personal taste and the other is pure reason, and although they are not new, one of them—personal taste—has never before presented itself so brazenly. The reasons given by Prof. Dingle for this revival are traced to the theory of relativity—a very remarkable thing when we remember that the very essence of that theory lay in the recall of science to experience. The solution of certain problems of classical physics lay in the fact that some concepts had been assumed to be directly related to experience, but the assumption was incorrect. For example, it was proved that by no physical process is it possible to determine unambiguously the absolute simultaneity of separated events. Hence, to establish science on its proper basis—that of experience—such concepts were eliminated, and experience was described "in terms of those concepts alone which had a precise empirical meaning"; the error which was corrected arose from incomplete consideration of the effects of changing the co-ordinate system. This subject is fully dealt with in Prof. Dingle's address.

Towards the end of the address the attention of the new cosmologists was directed to biology, in which a problem somewhat similar to that confronting cosmologists arises: "We observe living matter and dead matter, but we never experience the creation of living matter out of dead matter alone". It may be assumed that in the past dead matter became alive by an unknown process, or we may suppose that the process has been going on eternally but at an undetectable rate. The first alternative is "against the spirit of scientific inquiry" according to the modern cosmologist, who presumably will be forced to postulate the continual animation of matter—a view which Prof. Dingle believes is ruled out by the cosmologists' own scheme. If the matter of which the earth is composed was created as separate atoms, it could not have begun to live for many millions of years, and hence terrestrial life must have begun at some particular epoch. To escape from the dilemma, the cosmologist must deny the existence of living matter—a most improbable attitude—or he must violate "the spirit of scientific enquiry".

Prof. Dingle concluded: "And so, when it happens that we have published, in the name of science, so-called 'principles' that, in origin and

character, are identical with the 'principles' that all celestial movements are circular and all celestial bodies immutable, it becomes my duty to point out that this is precisely the kind of celebration that science was created to displace. . . . In cosmology we are again, like the philosophers of the Middle Ages, facing a world almost entirely unknown".

NATIONAL RESEARCH DEVELOPMENT CORPORATION: CONTINUATION OF BORROWING POWERS

THE Development of Inventions Bill, as foreshadowed in the fourth annual report of the National Research Development Corporation (see *Nature*, February 6, p. 249), received its second reading in the House of Commons on January 26. The Corporation's borrowing powers under the 1948 Act expire on June 30, 1954, and the Bill extends from five to ten years the period during which advances may be made to the Corporation and payment of interest on such advances waived. Numerous tributes to the work of the Corporation were paid during the debate, and in moving the second reading of the Bill, the President of the Board of Trade, Mr. P. Thorneycroft, explained the purposes of the clause which slightly extends the scope of the Corporation's activities. There appeared to be some doubt as to whether under the original Act the Corporation was empowered to carry out research for the purpose of developing an existing invention if this should lead to a substantially new invention. The first sub-section of Clause 2 of the new Bill is intended to remove this doubt and authorizes the Corporation to promote or assist any research likely to further the development or exploitation of inventions or to enhance their value.

The second sub-section of this same clause, Mr. Thorneycroft explained, arose from a comment in the last report of the Advisory Council on Scientific Policy as to the desirability of extending the existing organization for the use of research and development contracts. The sub-section authorizes the Corporation to promote and assist research intended to satisfy specific practical requirements where the Corporation believes the research is likely to lead to an invention, while a further sub-section of the clause empowers the Corporation to assist the continuation of a research which hitherto has proved fruitless from a practical point of view but which appears likely to lead to practical results. Exercise of its functions under these two sub-sections is subject to the approval of the Lord President of the Council and of the President of the Board of Trade.

Mr. Thorneycroft explained that this proviso was introduced to avoid the overlapping of the work of the Corporation and that of the universities, of other government departments or of research organizations like the Medical Research Council or the Department of Scientific and Industrial Research. He also stressed the point that the Corporation's task is to promote and assist research. It is not primarily to undertake research, he said, and is never to undertake it in competition with industry or with other government departments. When the Bill received its third reading on February 1, the Parliamentary Secretary

to the Board of Trade added further that it was never intended to give the Corporation general powers to undertake surveys or investigations to discover the practical needs of industry. That, he said, can best be done by industry itself, though possibly with the help and encouragement of government departments and at the suggestion of the National Research Development Corporation. Once such an investigation has established the prospect of industrial benefit, the powers to be given to the Corporation will enable it to take the responsibility for getting the required research done.

Two comments which were made during the debate on the second reading of the Bill are of particular interest. Mr. John Edwards, in welcoming the Bill, pointed out that the National Research Development Corporation is now inevitably involved in the provision, in a modest way, of risk capital, and he thought that the Bill would enable the Corporation to make a further contribution towards restoring a balance between the proportion of the resources devoted to fundamental research and those devoted to development. Mr. Austen Albu, who estimated the total expenditure during 1951 in Britain on research and development to be £268 million, of which £70 million was for civilian research, stressed the need to stimulate backward industries and to avoid overlapping. In some research associations, he said, there is a belief that projects in their field are sometimes undertaken in government establishments; and Mr. H. Strauss assured him that the reference to the President of the Board of Trade and the Lord President of the Council was designed simply to prevent such overlapping.

COMMONWEALTH FUND, NEW YORK

REPORT FOR THE YEAR 1952-53

THE thirty-fifth annual report of the Commonwealth Fund* covers the year ending June 30, 1953, and deals primarily with the activities for which grants were made during 1952-53. For medical education appropriations during the year totalled 602,977 dollars, for experimental health services and hospital activities 224,323 dollars, for medical research 517,101 dollars, for advanced fellowships in medicine and allied fields 75,000 dollars, for the Division of Education 310,050 dollars, and a special grant of 2,750,000 dollars was made for the construction of a dormitory, to be known as the Edward S. Harkness Memorial Hall, for medical students at Yale University. Actual disbursements during the year from current and previous appropriations totalled 2,584,179 dollars. Among the nine projects in medical education for which new or renewed appropriations were voted are a programme at Cornell University Medical College to provide students with a wider experience in medical care through continuity of contact with patients; grants to the University of Pennsylvania School of Medicine for the continuance of its family adviser programme until it is fully incorporated in the University framework, and for a year's pilot-study of the medical school as an educational environ-

* The Commonwealth Fund. Thirty-Fifth Annual Report for the Year ending June 30, 1953. Pp. x+28. (New York: Commonwealth Fund, 1953.)

ment; a revised teaching programme at the Medical School of Western Reserve University, in which a systematic effort is being made to correlate basic science subjects with clinical ones; and further support to the study of psychiatry and its relation to medicine at Washington University, the University of Louisville and the Saskatchewan Department of Public Health.

The Fund continued its support of the major experiment in integrated health care in Hunterdon County, New Jersey, where a medical centre that was opened in June 1953 is testing the theories of its long-term planning. A further grant to Hunterdon was for a county-wide health inventory, and a grant was made to the Rip Van Winkle Foundation towards the development over three years of a mental health programme for Columbia County. Another grant went to the National Opinion Research Centre in Chicago for the completion of its national survey of opinion about mental health and illness, and support was also given to the qualitative study at the Yale Psychiatric Clinic of the effect of interactions between patients and staff and between the different ranks of staff on the daily life and therapeutic effectiveness of a psychiatric ward.

During the year the Fund reviewed its interests in the field of medical research to which over seven years it has given nearly three million dollars for fifty-seven projects. Projects for which support was discontinued were largely in the fields of infectious disease, cardiovascular disease and cancer research, where major support is now received from other sources. Current research grants cover nine projects, one of which was new in 1952-53, and are in three categories: the first, which is primarily concerned with interaction between organism and environment, includes studies of growth and personality development, certain types of neuro-psychiatric research and studies of relations between social environment and chronic disease; the second deals primarily with integrative processes within the organism and includes studies of the neurological and endocrine systems and their relations; and the third is weighted in favour of basic biological studies.

Advanced fellowships awarded during the year included four in medicine or surgery, one for advanced work in psychiatry, and five for interdisciplinary studies as well as two fellowships to foreign workers. The programme of fellowships offered to British graduates, journalists and Civil servants for study and travel in the United States was broadened in 1952 to include persons on the Continent of Europe by a series of awards for candidates from the Salzburg Seminar in American Studies. Forty-nine Fellows in all categories were in residence in the United States during the year beginning September 1952, including nine British Fellows of the 1951 class who were granted extensions. For the present year, fifty-nine Fellows will be in residence, including thirty-seven on new awards and seventeen on extensions, the two-year figures including sixteen 'Salzburg' Fellowships. For the latter the Fund has been experimenting with a new plan of selection in which it has been possible to make nominations after a month's daily experience with the participants. Experience over the years is heavily in favour of the tenure of at least one full year, including two or three months of travel in the United States, and stress is laid on the value of the fellowships in developing leadership, and also in encouraging the exchange of ideas and information.

DEFENCE STANDARDS LABORATORIES, AUSTRALIA

REPORT FOR THE YEAR 1952-53

SINCE the transfer to other sections of the Research and Development Branch of the Department of Supply, Commonwealth of Australia, of research and development work on new weapons, the Defence Standards Laboratories, which have now been incorporated in the Research and Development Branch, have concentrated on scientific advisory service, and the Chief Superintendent's annual report* for the year ended June 30, 1953, indicates the new functions and scope of the Laboratory. Broadly, they are the application of scientific knowledge and research in chemistry, physics, metallurgy and engineering to problems arising in design, development, manufacture, inspection, storage and use of defence material. They include the provision of a scientific advisory service and the research required to provide a sound basis for such service. Its standardizing work is based on sub-standards verified in terms of the national standards held by the National Standards Laboratory, Sydney, and the staff also participate in specification drafting work of the Standards Association of Australia. The testing work involves the use of an extensive range of measuring instruments of proved accuracy.

Among investigations to which reference is made in the present report are detailed studies of the direct production of polymeric butyl titanate on a pilot-plant scale, giving yields of more than 80 per cent. Pigmentation of this polymer with zinc dust gives a paint with outstanding anti-corrosive properties, particularly under marine conditions, and anti-fouling paints based on such polymers pigmented with copper oxide and mercuric oxide are also being developed. Further progress has been made in the study of indigenous drying oils, and five new paint-exposure sites were brought into use during the year. Oxidation tests and the oxidizing characteristics of mineral oils are being studied with the view of establishing tests for identifying the type of an oil, and studies are being made of type and degree of damage in flax, jute and sisal fibres due to fungal and other agencies. The ebullioscope method of determining the molecular weights of polymers has been used extensively in the preparation of polymers of butyl titanate and styrene, and some experience was gained in the preparation of cellular (foamed) plastics.

In metallurgical chemistry a rapid test was developed for detecting porosity in nickel coatings on zinc-base die coatings, and much work was done on anodic passivation phenomena encountered in the anodic etching of low-alloy steel in dilute sulphuric acid. Chromate has proved to be a satisfactory inhibitor of corrosion in a spray-tower heat-exchanger circuit, and work was completed on some aspects of the mechanism of corrosion inhibition on mild steel in dilute sulphuric acid solution when very small amounts of organic inhibitors are added. A modified procedure was developed for determining phosphorus in all classes of iron and steel. In crystal physics more attention is now being given to long-

* Research and Development Branch of the Department of Supply, Commonwealth of Australia. Annual Report of the Defence Standards Laboratories for the Year ended 30th June, 1953. Pp. 54. (Melbourn, Vic., Alexandria, N.S.W., and Finsbury, S.A.: Research and Development Branch, Department of Supply, 1953.)

range research, particularly the application of X-ray diffraction in metal physics, including the influence of prior deformation on the structural changes associated with the creep of high-purity aluminium, and a detailed study of the structural changes during the tertiary creep stage in this metal. A complete structure analysis has been made of the fibrous silicate, amosite.

The Electricity Group has developed a microwave spectrograph for analysing the molecular structure of gases and has continued investigations on the scattering of electrons from solids, where the electrostatic analyser holds most promise of success in measuring the energy distribution. In optics the Zernike phase-contrast test, the Johnson-Scholes interferometer and the Bates sheared-wave interferometer have been added to existing techniques for testing optical surfaces, while an experimental Schmidt-Cassegrain objective, 50 in. in focal length, is being developed. The technique of making metal bolometers of small time-constant to function as infra-red receivers has been developed further, while in physical metallurgy investigations into the behaviour of metals in service have included studies of inter-crystalline corrosion in aluminium alloys. In welding metallurgy, much useful information on brittle failure, strain ageing, quench ageing and residual welding stresses has been accumulated.

An investigation is now being undertaken into variation of pore-size, specific surfaces and general adsorption capacity of a series of sulphur-impregnated activated charcoals.

Details of the work of the New South Wales and the South Australia branches are included, and lists of publications and lectures, of committees and of senior and professional staff at June 30, 1953, are appended.

ENERGY TRANSFER IN MACROMOLECULES EXPOSED TO IONIZING RADIATIONS

By DR. P. ALEXANDER

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IN gases there is abundant evidence¹ that the energy absorbed from ionizing radiations by one molecule can appear in another by transference of charge and excitational energy. In aqueous solution the energy absorbed by the water causes a change in the solute; since this process is now known to be brought about through the intervention of free radicals, the general term of energy transfer need not now be applied to these reactions². Recently, Manion and Burton³ found that the decomposition of cyclohexane was decreased in the presence of benzene, which presumably took up the energy from the excited or ionized cyclohexane molecule before this had dissociated. In all these cases collision between the molecules concerned is possible and, though there is no difficulty in principle, there is only limited evidence⁴ that energy from ionizing radiations

can be transferred within solids when the molecules are relatively immobile. A related effect is the transfer of energy within the same macromolecule from one part to another. Svedberg and Broholt⁵ observed that the giant molecule haemocyanin is split into identical parts by the traverse of a single α -particle, although the density of ionization makes it extremely unlikely that a single ionization can occur at a given site. This highly specific behaviour can be understood if energy absorbed anywhere within the giant molecule is mobile and able to break the bonds which hold the sub-units together. The smaller proteins which have been examined do not react in this manner but are degraded at random by α -particles to give a heterogeneous product. The following experiments with synthetic polymers provide direct evidence for energy transfer in saturated macromolecules of different constitution.

Polymethylmethacrylate is degraded at random by γ - and pile-irradiation, and from the simple function relating molecular weight with radiation dose it could be computed that one main-chain bond was broken for every 81 eV. energy absorbed⁶. This energy is not used only for main-chain breakdown but also includes associated reactions, such as decomposition of the ester side-chain, which occur simultaneously. When films of polymer containing 10 per cent of allylthiourea, aniline or *dimeta*-tolyl-thiourea were irradiated, 143, 152 and 227 eV. respectively had to be taken up by the system before a main-chain bond was ruptured. This protective effect, occurring in a system where the action of the radiation is 'direct', is now being studied in detail by Mr. D. Toms, whose preliminary experiments indicate that over a wide range protection is approximately independent of dose and proportional to the concentration of the added substance. The amount of radiochemical change which the latter undergoes is greater in the presence of the polymer than when it is irradiated alone. It seems likely, therefore, that the protection of the polymer is the result of energy transfer to the added substance. Since the area of the polymer molecules which is in physical contact with the additives can only be small, energy absorbed by ionization or excitation must be distributed over comparatively long distances before it can be taken up by the protective agent.

Polyisobutylene, like polymethylmethacrylate, is degraded by γ - and pile-irradiation, and from changes in molecular weight a value of 17 eV. was obtained for the energy absorbed per break in the main chain⁷. A co-polymer of 20 per cent styrene and 80 per cent isobutylene (kindly provided by Dr. Butler, of the Polymer Corporation, Canada) is more resistant than the pure isobutylene, and the energy required to break a main chain is increased approximately twice to 32 eV. The protection in this case can be interpreted as energy transfer from the isobutylene part of the chain to the aromatic ring system of the styrene, in which the energy is dissipated with only a very small amount of chemical change⁸.

In a similar way, the dose required to render a straight-chain hydrocarbon infusible (that is, to cross-link it to give an infinite network) is greatly increased by the presence of an aromatic ring. Cross-linking is the predominant reaction⁹ when straight-chain hydrocarbons are irradiated, and there is little, if any, chain breakdown. Although the energy required to produce a cross-link (c. 20 eV.) is independent of chain-length, the dose needed to render a

DOSE IN PILE UNITS* REQUIRED TO RENDER SUBSTITUTED DODECANES INFUSIBLE

Substituent	1-dodecane	4-dodecane	6-dodecane
1' naphthyl	48	—	—
2' naphthyl	48	62	66
2' decyl	—	—	37

* The pile unit is defined as a flux of 10^{17} slow neutrons/cm.² plus the associated γ -rays and fast neutrons. Comparison of cross-linking and degradation produced in the pile and by γ -rays from a cobalt unit indicates that one unit is equivalent to 4.5×10^4 r. for these reactions.

The compounds were kindly provided by Dr B. Bannar, of the Dyson Permas Laboratory, Oxford.

hydrocarbon infusible varies inversely as the molecular weight, since an average of one cross-link per molecule (weight average) is required for this change to occur. To render dodecane infusible, 27 units of pile-irradiation are required.

The addition of the saturated polycyclic hydrocarbon decalin at the centre of the paraffin molecule increases the dose slightly, whereas the presence of the aromatic naphthalene ring may render the straight chain much more difficult to cross-link, although any steric factors which could influence the reaction will be very similar in the two cases.

Since the amount of energy absorbed by the paraffin chain is not altered by the addition of other groups, we must conclude that the energy has been transferred to the aromatic ring before it could bring about the chemical changes leading to cross-linking. The table shows that maximum protection occurs when the aromatic ring is at the centre of the paraffin chain, and that the effect is smallest at the end. This suggests that energy transfer can occur along a saturated chain of twelve carbon atoms, but that it is more effective over shorter distances. The data indicate that the saturated ring exerts a small protective effect and that it contributes nothing to the cross-linking, since the corresponding C_{12} straight-chain paraffin, because of its higher molecular weight, required only 12.3 units to be rendered infusible.

The occurrence of energy-transfer processes in organic macromolecules may play an important part in the biological actions of ionizing radiations, since, as we have shown here, such transfers can result both in a decrease of total reaction by concentrating the energy in a group resistant to radiation, or by the preferential decomposition of a particular component. For example, the possibility can now be envisaged of protecting against a 'direct effect', since macromolecules need not decompose immediately on becoming ionized and can transfer their energy without undergoing reaction if a suitable receptor is present. Consequently, it cannot be concluded that any effect against which protection can be achieved by the addition of chemicals must invariably be the result of reactions with free radicals produced in the surrounding medium.

For the smaller viruses, Lee¹⁰ had found that an ionization anywhere within the organism leads to inactivation. The conclusion that every part of the virus was equally vulnerable is in contradiction to biochemical experiments, which had shown that many groups of the macromolecule could be modified without loss of activity. The results reported here indicate that the difficulty may be resolved if the target represents the distance over which energy transfer can take place, whereas the sensitive region

is smaller. If this view is accepted, 'direct' and 'indirect' are not fundamentally different, but represent merely two different mechanisms by which energy provided by ionizing radiations to the system as a whole is concentrated at definite points. The reactions produced in a complex structure by direct transfer of energy may be more selective than those brought about by the indirect action of highly reactive free radicals, and this may explain the much higher efficiency of direct action for the inactivation of viruses¹¹.

This communication is published by permission of the Director of the Atomic Energy Research Establishment. The investigation has been supported by a special grant from the Anna Fuller Fund and by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. [Dec. 29.]

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⁴ Swank, R. K., and Buck, W. L., *Phys. Rev.*, **81**, 927 (1953).

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⁶ Alexander, P., Charlesby, A., and Rom, J., M.O.S. Report, A.E.R.H. M/R 1309; *Proc. Roy. Soc.* (in the press).

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⁹ Charlesby, A., *Proc. Roy. Soc.*, **A**, **115**, 187 (1953).

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¹¹ Lee, D. H., Smith, K. M., Holmes, B., and Markham, R., *Parasit.*, **38**, 110 (1944).

AFTER-EFFECTS OF X-IRRADIATION OF DEOXY-RIBONUCLEIC ACID

By DR. B. E. CONWAY

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THE change of viscosity of deoxyribonucleic acid (DNA) brought about by X-irradiation was shown by Taylor, Greenstein and Hollaender¹ to continue long after the termination of the irradiation. Butler and Conway² found that after irradiation of deoxygenated solutions of DNA the viscosity remained nearly constant after a small initial fall during the first hour or two. They therefore concluded that the 'slow' after-effect, following irradiation in oxygen, was due to a product of the primary radicals with molecular oxygen. Possible products are HO_2 radicals and molecular H_2O_2 , and it was shown that hydrogen peroxide, although present and responsible for some of the after-effect, was not capable of accounting for the whole of it. It was suggested that the remainder of the effect might be due to the slow decomposition of peroxidic derivatives of the nucleic acid.

Recently, Daniels, Scholes and Weiss³, using slightly different experimental conditions, observed an after-effect in deoxyribonucleic acid solutions irradiated *in vacuo*, which was about one-third of

that found with oxygenated solutions. They therefore suggested that the effect of oxygen was merely an enhancement of an effect which already occurred in its absence, namely, the slow hydrolysis of deoxy-pentose-phosphate internucleotide links made labile by oxidation by the radicals at the C_4' position on the pentose^{4,5}. The enhancement of this effect by oxygen they supposed to be due to elimination of back reactions, thus leading to an increased oxidation yield.

I have made experiments to ascertain the cause of this discrepancy between the results of Daniels, Scholes and Weiss⁴ and those of Conway and Butler^{5,6}.

Solutions of a highly polymerized specimen of DNA (0.1 per cent) were prepared *in vacuo* in an all-glass apparatus, in which water was distilled *in vacuo* into ampoules containing the DNA, from a vessel in which it had been previously deoxygenated by refluxing at atmospheric pressure in argon, made oxygen-free by passage through alkaline pyrogallol, and then over copper gauze heated to about 450° C. and finally through a trap in a solid carbon dioxide-ethanol mixture. The ampoules were detached and the deoxyribonucleic acid allowed to dissolve for about 36 hr.: the solutions were then irradiated with 140-kV. X-rays (half-value layer thickness 0.04 mm. copper) to give a dose of 10,000 r. at 166 r./min. Oxygenated solutions were prepared by bubbling oxygen through the solution for 15 min. immediately prior to the irradiation. The viscosity of the solutions was measured as soon as possible after the termination of the radiation in Frampton type viscometers at shear-rates between 50 and 250 sec.⁻¹. When the experiments were carried out under these conditions, I was able to reproduce the observations of Daniels *et al.*⁴; I examined a number of factors such as shaking the solutions for 12 hr. before radiation) introducing various types of grease, keeping the solutions in argon or nitrogen instead of *in vacuo* during the irradiations, but so long as the viscosity was measured directly (see below) on the irradiated solutions an after-effect of about one-third of that found in oxygen was usually observed (Fig. 1). However, when the experiment was carried out under the conditions which we used in our earlier work^{3,4}, namely, irradiation of solutions at 0.2 per cent concentration, followed by dilution to 0.1 per cent with twice-distilled water immediately after the irradiation and before the viscosity measurements were commenced, the after-effect *in vacuo* was largely sup-

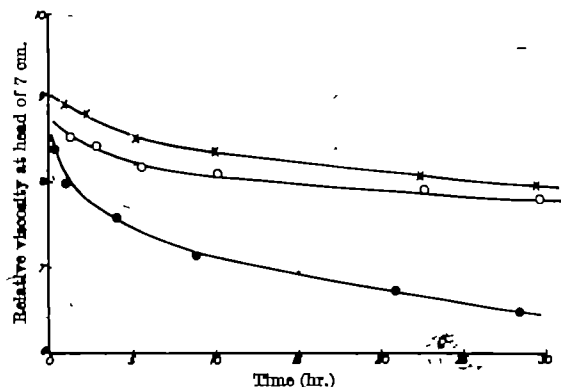


Fig. 1. After-effect of X-irradiation (10,000 r.) measured directly on 0.1 per cent deoxyribonucleic acid solution
O, *in vacuo*; X, *in vacuo* with grease; ●, in oxygen

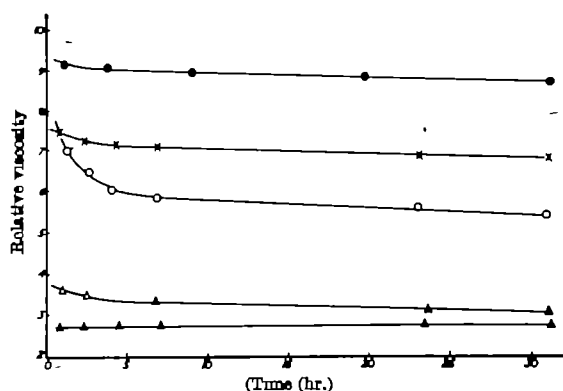


Fig. 2. After-effect of X-irradiation (10,000 r.) measured after dilution of 0.2-0.1 per cent solution
●, control
+, *in vacuo*
O, *in oxygen*
Δ, *in vacuo*
Δ, *in oxygen*
in water
in 0.1 N aq. sodium chloride

pressed and was no greater than the slow change of viscosity which occurred after diluting a 0.2 per cent solution to 0.1 per cent. When the 0.2 per cent irradiated solutions were diluted, 1:1, with 0.1 N sodium chloride the viscosity was quite constant for 48 hr. (Fig. 2). Dilution, either with water or 0.1 N sodium chloride, of the 0.2 per cent solutions irradiated in oxygen did not eliminate the after-effect. The discrepancy in the results thus appears to be due to the fact that Daniels *et al.*⁴ measured viscosities of the solutions as irradiated, whereas Conway and Butler, for reasons of experimental convenience, diluted their solutions $\times 2$, after irradiation before the viscosity measurements were commenced.

The fact that the *in vacuo* after-effect can be largely eliminated by dilution raises the question whether the slow changes observed in this case in non-diluted solutions can be attributed to a chemical process at all, for example, to the slow hydrolysis of labile internucleotide linkages (see above) as suggested by Scholes and Weiss^{4,5}.

The viscosity of solutions of deoxyribonucleic acid at moderate concentrations is largely due to the interactions between the particles^{7,8} and is not related in a simple way to the length of the polynucleotide chain. It is possible to destroy the abnormal high viscosity without any appreciable change of molecular weight⁹. Viscosity changes cannot, therefore, be taken as solely due to breakages of the nucleotide chain resulting from the oxidation of the sugar; various lines of experimental evidence show that viscosity changes can occur by changes in the intramolecular hydrogen-bonding and in intermolecular interactions.

The elimination of the after-effect by dilution suggests that in the experiments without dilution the after-effect is largely the result of a slow readjustment or equilibration of the interactions between the particles due to their modification in shape, size and charge by the chemical processes occurring during the irradiation. Dilution with water or salt solution presumably immediately introduces much larger changes of interaction between the particles, so that the slow effects which would otherwise be apparent are no longer significant.

With regard to the large after-effect produced by irradiation of oxygenated solutions, the mechanism is complex; it is an undoubted fact that: (1) hydrogen peroxide is formed; (2) hydrogen peroxide is

capable of degrading irradiated deoxyribonucleic acid^{4,10}. In the mechanism of the after-effects discussed by Daniels *et al.*⁹, this effect of hydrogen peroxide in the oxygenated solution has not been considered. It is quite possible that some part of the after-effect observed in oxygen is due to slow hydrolysis of sugar phosphate groupings labilized by oxidation at the C_{4'} position as Scholes and Weiss suggest.

However, the suggestion by these authors, that in oxygen the formation of unstable peroxidic intermediates of the deoxypentoses in nucleic acid may be more important than direct oxidation by OH radicals, is not unlike our own^{4,10}.

It seems likely that all three processes, namely, the formation of labile phosphate esters, the slow decomposition of peroxide intermediates and the interaction of hydrogen peroxide, formed during the irradiation in oxygen, with the deoxyribonucleic acid damaged by radiation¹⁰, may be involved simultaneously in the after-effect observed in oxygenated solutions. The recent proposal by Watson and Crick¹¹ of a double-chain helical structure for deoxyribonucleic acid, in which the chains are held together by hydrogen bonds between the heterocyclic bases, makes possible the consideration of another type of process which might occur slowly after initial damage to the chains by certain radicals. If the chains of a linked pair are broken at some points not immediately opposite one another, and some damage, for example, a deamination, ring fission, etc.^{4,12}, is caused to the bases, a slow rearrangement such as untwining or collapse of the helical rod-like structure might occur during a period of time after the initial damage.

It might have been expected, on the theory advanced by Daniels, Scholes and Weiss, that if the greater after-effect in oxygen is due to an enhanced oxidation, the primary effect of irradiation would also be greater in this case. Daniels *et al.* state, however, that the primary effect of irradiation in oxygen is less (about 50 per cent) than that *in vacuo*. It is not easy to see how they reconcile this observation with their theory; their results could only be explained if it is supposed that hydrogen atoms are much more effective in immediate depolymerization of deoxyribonucleic acid than the HO₂ radicals formed from them in oxygenated solutions. In our own experiments, on the other hand, it has consistently been found that viscosities measured very soon after irradiation *in vacuo*, nitrogen or oxygen are closely similar, in agreement with the observations of Smith and G. O. Butler¹³, and Limperos and Mosher¹⁴.

A further experiment has been designed especially to test this point again. 0.1 and 0.2 per cent solutions of deoxyribonucleic acid were made up *in vacuo* in one limb of double ampoules in the form of an inverted U. When the nucleic acid was dissolved completely, the solution was divided equally between the two ampoules by tipping the U-tube. This procedure was used in order to make the comparison on identical solutions, since some variations occur in the viscosity of solutions of deoxyribonucleic acid of the same concentration made up separately at different times. The solution in one side of the double ampoule was then irradiated, still *in vacuo*, with 10,000 r., while the other limb was shielded in a thick lead pipe. After the radiation, the viscosity of the solution was measured between 50 and 250 sec.⁻¹ in the Frampton viscometer. Oxygen was then passed into the second half of the solution contained in the other ampoule, and this was then

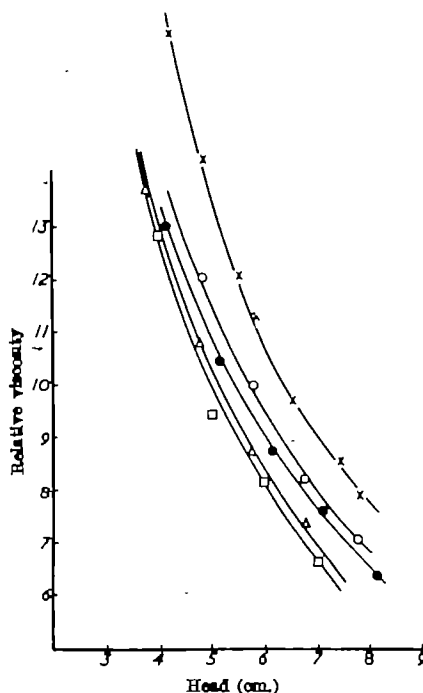


Fig. 3. Primary effect of X-irradiation (10,000 r.) *in vacuo* and oxygen
 x, control; ●, 0.1 per cent *in vacuo*; ○, 0.1 per cent in oxygen;
 □, 0.1 per cent after dilution from 0.2 per cent, *in vacuo*;
 Δ, 0.1 per cent after dilution from 0.2 per cent, in oxygen

irradiated similarly and its viscosity determined. After the irradiation, the viscosity of the solution irradiated *in vacuo* was only 4 per cent less than that of the solution irradiated in oxygen (Fig. 3). We cannot, therefore, agree that the primary effect in oxygen is greatly different from that *in vacuo*, as maintained by Daniels, Scholes and Weiss. These results suggest, then, that the after-effect in oxygen is due mainly to distinct processes not involved to any great extent in the primary effect in either oxygen or *in vacuo*.

Acknowledgments. I wish to thank Prof. J. A. V. Butler for his interest in the work and for many helpful discussions and suggestions, and Dr. L. F. Lamerton for providing facilities for carrying out the X-irradiations. This investigation has been supported by grants to the Royal Cancer Hospital and the Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. [Dec. 29.]

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LETTERS TO THE EDITORS

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Temperature Acclimatization in Insects

Among the voluminous literature on temperature and poikilothermal activity, an occasional paper is found dealing with temperature acclimatization. The majority of work has been carried out with fish.

With respect to insects, Mellanby^{1,2} showed for a number of species that their activity at low temperatures was modified by their previous thermal history, thus indicating that insects became acclimatized to temperature. Thermal acclimatization experiments have been carried out with the German cockroach, *Blattella germanica* L. and some of the experimental evidence is presented below.

The relation between acclimatization temperatures and activity at low temperatures above freezing is shown in Fig. 1. It is evident that insects kept at 15° C. are able to remain active at temperatures at which others from 25° C. and 35° C. are immobilized by cold. Acclimatization to cold is not an unlimited process, which is illustrated in Fig. 2, where cold immobilization or 'chill-coma' temperatures are plotted against their corresponding acclimatization temperatures. The 'chill-coma' temperature of *B. germanica* acclimatized at 10° C. is the same as for those acclimatized at 15° C. This suggests that acclimatization is only possible within a certain temperature-range.

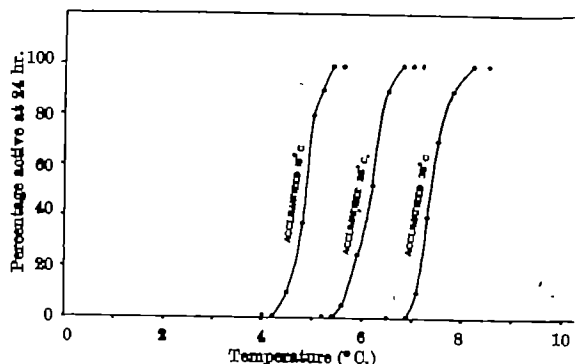


Fig. 1 Relation between acclimatization temperatures and activity at low temperatures for males of *B. germanica*

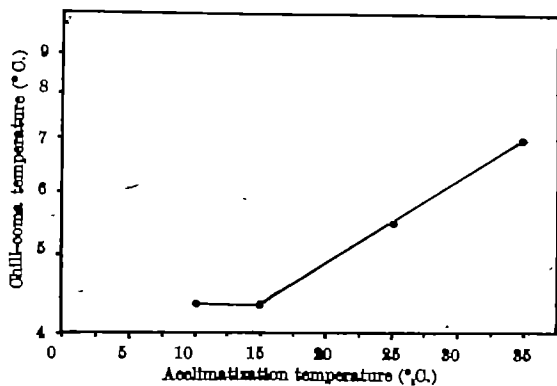


Fig. 2 Relation between 'chill-coma' temperatures and acclimatization temperatures for males of *B. germanica*

Experiments have also been carried out on survival at 7° C. of *B. germanica* acclimatized at 35° C., 25° C. and 15° C. Insects from 15° C. lived longer than those from either 25° C. or 35° C.; the 35° C. group died most quickly. This implies that much of the previous work on cold-death points at temperatures above freezing is invalidated. The cause of death at low temperatures is unknown, but insects immobilized by cold for a given period showed signs of a nervous disturbance which was not reversible.

This and other phases of the work will be published more fully elsewhere.

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² Mellanby, K., *J. Animal Ecol.*, 9, 206 (1940).

Acclimatization and the Thermal Death Point in Insects

Insects, like other cold-blooded animals, are active over a range of temperature, limited below by the chill coma point, and above by the heat coma point (closely related to the thermal death point, that is, the upper lethal temperature, for they cannot recover from long periods of heat coma). On the whole, the heat coma point is higher for insects from warm regions, and the chill coma point is lower in those from cool regions.

The chill coma temperature can be readily altered. I showed some years ago that in a number of species exposure for as short a period as 24 hr. to warmer or cooler conditions within the normal range will modify the chill coma point substantially, in some species by as much as 7.5° C.^{1,2}

I now find that the heat coma point and the thermal death point can similarly be rapidly changed by keeping insects at different temperatures for periods of only 20 hr.; longer exposure gives no further adaptation. Thus, in the mealworm, *Tenebrio molitor*, larvae from cultures kept at 37° C. for 24 hr. have a thermal death point, for a one-hour exposure, of 44° C.; those kept at 30° C. or below have a thermal death point of 42° C. The results for larvae of the mosquito *Aedes aegypti* are very similar. Two facts are apparent when these results are compared with the low-temperature experiments: (a) the range over which the thermal death point can move is much smaller than that over which the chill coma temperature can be changed; (b) substantial changes in the thermal death point are caused only by previous exposures to temperatures towards the top of the range over which the insects can survive, whereas low-temperature adaptation occurs over the whole range.

Insects acclimatized to high temperatures thus survived exposures which killed unacclimatized insects. It was noticed, however, that they did not continue their development and moult or pupate at the same time as unheated controls. It seems that sublethal exposures to heat may destroy the internal secretions which control these processes. I showed³ that if the blow-fly larva *Lucilia sericata* is kept at a high temperature for several days it goes into diapause, while controls pupate. Wigglesworth⁴ has similarly shown that at temperatures above the optimum the bug *Rhodnius prolixus* does not moult.

The experiments described here show that much briefer exposures to high temperatures interrupt development, but that after a delay (of perhaps a month in *Aedes*) normal pupation occurs and adults are then produced after the usual interval.

This extended life-history in insects may be of practical importance. In Nature, insects may often be exposed to temperatures similar to those used in these experiments, and if this causes a substantial prolongation of the life-history, it may give rise to unexpected emergences of insects which are important vectors of disease or pests of stored products.

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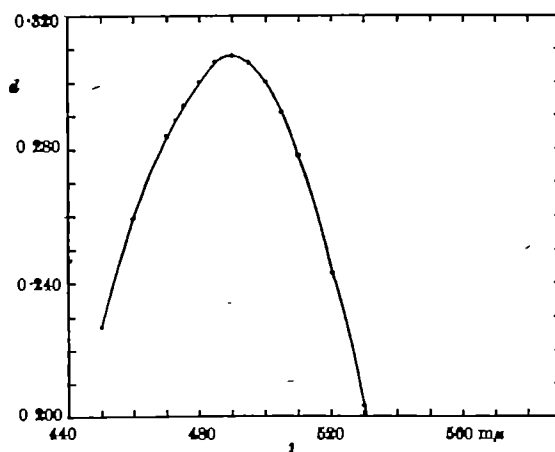
An Acidogenic Carotenoid in a Bathypelagic Nemertean Worm

CERTAIN brightly coloured littoral nemerteans contain carotenoids, and it is likely that most deep-sea species of similar coloration likewise store this class of biochrome¹.

Recently, there arose a rare opportunity to examine briefly the red-orange pigment from three freshly collected specimens of *Nectonemertes mirabilis* Verrill (one immature male and two females, 30–34 mm. long and 5 mm. wide). These were taken in a depth haul from 1,200 m. to the surface in the Santa Barbara Passage off the coast of Southern California by Dr. N. T. Mattox at the Allen Hancock Foundation, and were presented to Prof. W. R. Coe of the Scripps Institution, who identified them as members of this widely distributed species, usually encountered at depths from 500 m. down, in the North and the South Pacific Ocean.

The specimens, fixed in dilute formalin, then preserved in 70 per cent ethanol, were examined within a week after capture. The deep red-orange pigment was concentrated in oil droplets in the digestive diverticula. In view of the unlighted habitat and the microcrustacean diet of this worm, it was of special interest to learn whether, as in numerous other marine carnivores, its richly stored pigment might belong to the oxygenated carotenoids¹.

The preserved worms had lost none of their bright colour, but substitution of absolute ethanol readily leached the pigment out, imparting a red-orange colour to the solvent and leaving the animals quite pale. The pigment was completely epiphasic, migrating quantitatively from the alcohol into light petroleum to give a yellow solution. However, after an hour's exposure to warm ethanolic potassium hydroxide, the pigment showed quantitative hypophasic behaviour, thus reflecting the absence of carotenes and the original presence of esterified xanthophylls. Dilution effected the migration of a trace of yellow pigment into the petroleum, while the more copious red component now separated as a potassium salt at the liquid interface. In its preferential solubility in alcohol, and in its reversible transference from alkaline or neutral alcohol to petroleum,



Absorption curve of acidogenic carotenoid derived from an ester occurring in *Nectonemertes mirabilis* Verrill

the yellow component behaved like a neutral xanthophyll. Its quantity was insufficient for further study.

The red interfacial salt was washed with additional petroleum and was then readily dissolved in this solvent containing a little acetic acid. The yellow petroleum solution displayed, on shaking with water, the transient pinkish emulsion which characterizes other acidogenic carotenoids, such as astaxanthin and metridioxanthin². The acid-free petroleum solution was evaporated in an inert atmosphere and the deep orange residue was dissolved in redistilled pyridine (b.p. 114–116° C.). This red-orange solution exhibited a single, discrete absorption peak whose steep, symmetrical shape and maximum at 490 mμ differentiated it from astaxanthin or its artefact, astaxene, which show a less sharp maximum at 500 mμ in the same solvent (Beckman photoelectric spectrophotometer; see accompanying figure). In its spectrum the nemertean pigment recalls a similar acidogenic carotenoid from the marine shrimp *Hippolyte*³ and another from the anemone *Metridium*⁴.

Evidently this deep-sea pelagic ribbon-worm owes its bright red-orange colour to the presence of an acidogenic carotenoid ester, related to but not identical with astaxanthin. The principal carotenoid and the accompanying traces of esterified neutral xanthophyll doubtless originate from the animal's consumption of planktonic crustaceans and other pelagic fauna. The finding of rich stores of oxygenated carotenoids, unaccompanied by any carotene hydrocarbons, adds to the growing list of xanthophyll-selecting marine carnivores¹, a widely occurring species the habitat of which is limited to great oceanic depths.

I acknowledge the generosity and help of Prof. Wesley R. Coe, and the welcome co-operation of Dr. Norman Millott in conducting the spectroscopic examination.

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In Vitro Cultivation of Mouse Ascites Tumour Cells for Virus-Host Cell Studies

KLEIN^{1,2} has found that the so-called Ehrlich ascites tumours of mice offer several advantages over solid tumours for studying the effect of a substance on the growth-rate, on nucleic acid content and on the cytomorphology of neoplastic cells. These advantages have been applied lately by a number of investigators^{3,4} to studies dealing with the effect of viral infection upon the neoplastic process and with the adaptation of virus to the ascitic cells⁵. These investigations have all been carried out in the peritoneal cavity of the mouse. An *in vitro* technique which may prove feasible for similar studies, particularly host-cell virus studies in neoplastic cells cultivated apart from the animal, was recently developed in our laboratory.

Ascites cell suspensions were freshly removed from tumorous Webster-strain white mice, centrifuged at 2,000 r.p.m. for 15 min. and the supernatant decanted. The cells were then resuspended in a nutrient medium composed of 50 per cent ox serum ultrafiltrate, 10 per cent chick-embryo extract and 40 per cent Hanks's balanced salt solution with 0.002 per cent phenol red indicator. Two hundred units of penicillin and 100 µgm. of streptomycin were added at first to preclude contamination. 1-c.c. aliquots were dispensed into Porter flasks in which were incorporated glass coverslips (11 mm. x 22 mm.) and the flasks incubated at 36° C. The medium was renewed daily for the first four or five days, the pH during this period showing diminutions from the 7.5 of the fresh medium to 6.6-6.8 within twenty-four hours. The fluid phase in the first twenty-four hours turned a chocolate-brown, due most likely to denaturation of haemoglobin from red blood cells carried over with the ascitic fluid. Thereafter, the medium was renewed at weekly intervals for six weeks. Coverslips were withdrawn from random Porter flasks at the time of fluid renewal and stained by the May-Grünwald and Giemsa method⁶.

Microscopic examination of the stained coverslips indicated that the ascites tumour cells maintained their usual appearance for at least the first week of culture. In the following weeks increasing numbers of cells showed progressive degeneration as manifested by increasing cytoplasmic vacuolation and karyoplasmic fragmentation. However, by the end of the sixth week there were still a considerable number of cells presenting a normal appearance. In this connexion, it should be mentioned that Hull⁷, employing a subculture technique, has succeeded in serially culturing a line of ascites tumour cells for more than eight months. The frequency of blood cells and wandering cells was of the order of only a few per cent and these were readily distinguishable.

The utilization of cells morphologically, functionally, and potentially alike would permit a far more exact evaluation of host-cell reactions with, and responses to, specific viruses under conditions of culture. The Ehrlich ascites tumour cells being maximally dedifferentiated⁸ do not manifest the protean ensemble of morphological forms so frequently observed with cells in culture, a phenomenon ascribed by Weiss⁹ to 'modulations'. In addition to the advantage of uniform cells, which is ordinarily provided only by continuous cultures maintained over long periods of time, the absence of a fibrin clot affords the cells a maximum exposure to the viral particles in the fluid phase. Also, the ready manipula-

tion and staining of the coverslips upon which the cultures grow permit a sequential study of cytomorphological development and change.

This investigation was aided by a fellowship from the National Foundation for Infantile Paralysis.

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Vaccination against Haemorrhagic Septicaemia of Bovines

HAEMORRHAGIC septicaemia kills many thousands of cattle and buffaloes in Asia each year. Vaccination with conventional products such as formalin-killed cultures of *Pasteurella multocida* have not been considered an effective form of prophylaxis although practised for the past thirty years or so. The serological typing of strains of the causative organism and studies on its antigenic structure have not been pursued extensively in Asiatic countries in the past. In recent studies sponsored by the Food and Agriculture Organization of the United Nations, strains of *P. multocida* recovered from field cases of the disease in south-east Asia were typed by the mouse protection method of Roberts¹; 14 Burmese, 3 Indian, 2 Pakistanian, 2 Malayan, 2 Siamese and one Indonesian strains were found to be type I. Only one other serotype was recovered from bovines—a single strain of type IV from Burma.

P. multocida type I is a small-capsule variety of *Pasteurella* which, unlike the large-capsule varieties, is not decapsulated by bull testis hyaluronidase. During the first and second subcultivations after primary isolation, type I strains are agglutinable only by low dilutions of homologous antisera, but in subsequent subcultivations agglutinability is increased by up to a hundredfold without any obvious change in morphology. At the same time, agglutinability of cells in cetyl trimethyl ammonium bromide declines. These facts suggest that type I strains may have an antigen analogous to the 'Vi' of *Salmonella typhosa*. Cultures relatively inagglutinable in homologous antisera have been provisionally called 'phase I' cultures and are used for vaccine production. Simple formalin-killed bacterins made from 'phase I' cultures have not been highly successful as prophylactic agents, only 1 of 11 and 11 of 16 bovines having been protected against a 25,000 lethal dose challenge four weeks after inoculation. However, when an equivalent dose of 'phase I' cells, formalin-killed, was incorporated in a mineral oil-lanolin emulsion and injected intramuscularly in a dose of 2 ml. the results were greatly improved. In a series of small experiments in Burma and Siam a total of 36 of 39 cattle and buffaloes were protected against 25,000-200,000 lethal doses injected subcutaneously four to five weeks after inoculation with adjuvant 'phase I'

vaccine. One out of five cattle inoculated with adjuvant 'non-phase I' vaccine survived comparable challenge. Animals with naturally acquired immunity were detected and eliminated from the experiments by a serum agglutination test using 'phase I' cells as the agglutinating suspension. Every one of twenty control unvaccinated cattle and buffaloes used in these experiments succumbed to the challenge dose of live culture. Experiments are continuing on a larger scale to test the duration of immunity and its effectiveness under field conditions. Details of the experiments mentioned above are being reported in full elsewhere.

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¹ Roberts, R. S., *J. Comp. Path.*, 57, 261 (1947).

Sodium : Potassium Ratio in the Hypophysis

It was observed in 1947¹ that the thyroid gland of the mouse specifically accumulates intravenously injected uranin (sodium-fluoresceinate); large concentrations of sodium are known to be present in the thyroid colloid. Similarly, we observed the appearance of uranin upon intravenous injection of its 5 per cent solution in high amounts in the hypophysis of mice, particularly in the posterior lobe of this gland².

The affinity of elements of the 'extracellular' group in general for the pituitary is suggested by the specific accumulation of radioactive iodine in its posterior lobe^{3,4}. It parallels the high molecular concentration of calcium and aluminium in the thyroid gland⁵ and of electropositive organic bromine compounds in the pituitary⁶.

Assuming a parallelism between the high sodium-levels and uranin accumulation, we determined by flame photometry the sodium and potassium content of the posterior and anterior lobes of the pituitary in large animals.

The organs were obtained at the slaughter house and placed in a deep-freeze box within 50-60 min. after death. We analysed glands from calf, cow, ox and steer; in the case of lambs' glands, the size of the glands available did not permit us to analyse the lobes separately. Weighed amounts of 0.8-1.5 gm. were heated to ash in a platinum crucible. The ash was taken up in a few drops of concentrated hydrochloric acid and again reduced to ash at red heat. The residue was then made up to 10 ml. with water and the appropriate dilutions were analysed in the flame photometer (apparatus of Process and Instrument Co., Brooklyn).

The moisture content, determined by drying at 105°, of the posterior lobe was, with a single exception, within the range of 71.5-75 per cent, the ash content 1.12-1.48 per cent. The corresponding figures for the anterior lobe were: moisture 76-81 per cent, ash 0.68-1.05 per cent.

The accompanying table summarizes the results, giving the concentration of the elements in milliequivalent values/100 gm. of tissue and also the molar quotients K/Na. Except for the posterior lobes in Nos. 1 and 3, the anterior lobe in No. 5 and the whole gland in No. 9, there is a consistent prevalence of sodium over potassium.

The predominance of sodium, and possibly of the entire 'extracellular' group of elements, seems to be

SODIUM AND POTASSIUM CONCENTRATIONS IN THE HYPOPHYSIS

No.	Animal	Posterior lobe		K/Na	Anterior lobe		K/Na
		Milli-equivalents per 100 gm. K	Na		Milli-equivalents per 100 gm. K	Na	
1	Calf	5.84	3.40	1.53	1.18	1.23	0.96
2	"	4.45	5.74	0.78	1.24	4.04	0.33
3	Cow	5.16	5.04	1.02	2.27	3.25	0.70
4	"	5.10	5.70	0.89	3.87	4.18	0.93
5	Ox	4.55	5.05	0.90	6.80	5.10	1.36
6	Steer	5.06	7.55	0.75	4.44	5.12	0.87
7	"	5.10	7.83	0.65	3.31	5.25	0.63
8	"	4.04	6.07	0.61	2.78	4.52	0.53
9	Lamb (whole organ)	7.65	4.54	1.68			
10	"	4.06	6.80	0.60			

particularly pronounced in the steer. The lowest potassium values were shown in the anterior lobe of the calf. We believe that the prevalence of sodium is a characteristic feature of the hypophysis throughout the mammals.

Comparisons of potassium and sodium content of animal organs⁷ show predominance of potassium in most of the internal organs and the highest values in the musculature and the erythrocytes. The lowest K/Na quotients, on the other hand, are shown by blood plasma, bone and skin. Like the thyroid, the pituitary gland belongs, according to our determinations, to this latter group of organs. The prevalence of sodium over potassium is shared in most cases by the posterior and anterior lobes.

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Diabetogenic Action of Pancreatic Glucagon

In previous experiments it has been shown that pancreatic glucagon, produced in the A cells of the pancreatic islets¹, significantly increases the blood-sugar-level and the urine glucose of intact rats, forcibly fed on a high carbohydrate diet; in these conditions glucagon also augmented the diabetogenic effect of pituitary somatotrophic and corticotrophic hormones as well as of cortisone. Combined treatment with glucagon and cortisone was the most effective in provoking a temporary diabetic condition².

We have now carried out experiments on intact, normally fed rats with either cortisone or glucagon alone and with combined treatment, in order to investigate further the possible role of glucagon in the disturbances of the carbohydrate metabolism.

Fifty-four male adult rats, weighing 118 ± 2.3 gm. at the start of the experiment, were fed on a synthetic diet containing 25 per cent proteins, 63 per cent

carbohydrates, 10 per cent lipins, 2 per cent McCollum salt mixture and supplements of vitamins and lipotropic factors; water was allowed *ad libitum*. The intake of food was kept constant, 15 gm. per 100 gm. of body-weight being allowed daily and regularly consumed. The animals were kept in metabolism cages and the urine collected daily.

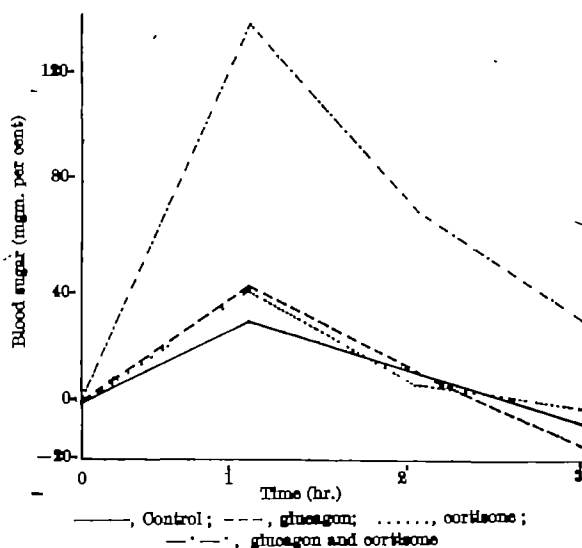
The animals were divided into three groups: 14 rats were treated with cortisone acetate ('Cortone' Merck), 5 mgm. daily subcutaneously; 16 with glucagon 1 mgm. of protein daily intraperitoneally in two divided doses; and 24 with cortisone plus glucagon, respectively 5 and 1 mgm. daily. Impure glucagon was prepared from alkali-inactivated insulin, according to the method of Sutherland and co-workers³; an amorphous insulin, rich in this factor and kindly supplied by Dr. W. R. Kirtley, Eli Lilly and Co. (lot ML 509948), was used for its preparation. Our preparation, tested intravenously in rabbits and on liver slices *in vitro*, showed a high hyperglycaemic and glycogenolytic activity. The treatment lasted twenty days. Fifteen days after the beginning of treatment glucose and insulin tolerance tests were carried out on ten animals per group; in the morning 0.5 gm. of glucose per 100 gm. of body-weight was administered by stomach tube, and blood samples taken from the tail 0, 1, 2 and 3 hours after the tube feeding; in the afternoon 0.1 I.U. of insulin per 100 gm. of body-weight was injected subcutaneously and blood samples taken in the same way. At the end of the experiment the animals were weighed and killed by sudden decapitation; the pancreas was fixed in Susa fluid and studied morphologically in sections stained with the Gomori chrome-haematoxylin and phloxyn method⁴.

During the experimental period the body-weight decreased 0.5 ± 0.1 gm. daily in cortisone group and 0.9 ± 0.2 gm. daily in cortisone plus glucagon group, whereas it increased 2.3 ± 0.2 daily in glucagon group. The occurrence of spontaneous infections in respiratory and digestive tracts was high in cortisone group (36 per cent) and was not evidently reduced by the simultaneous administration of glucagon (30 per cent); no infections were observed in glucagon group.

A dosable glycosuria was never observed in cortisone and glucagon groups, while the animals having combined treatment displayed constantly an appreciable glycosuria, beginning at the 7-9th day of treatment and gradually increasing in the following days up to 50 per cent. After stopping the treatment glycosuria promptly disappeared. The fasting blood sugar was 164 ± 18 mgm. per cent in the animals having combined treatment, while in cortisone and glucagon groups it was respectively 84 ± 8 and 105 ± 7 mgm. per cent.

The hourly changes of the blood sugar in the glucose tolerance tests are recorded graphically in the accompanying figure. From this it appears that the tolerance was practically normal in cortisone and glucagon groups, while in animals having combined treatment it was evidently lowered. As regards the insulin test, the combined treatment only resulted in some resistance to the insulin.

At the histological examination of the pancreatic islets, no striking regressive changes were demonstrable; a mild degree of hydropic degeneration was sometimes detectable in B cells of the animals having combined treatment. In all groups the B cells were hypertrophied and showed poorly granulated cytoplasm; mitotic figures were exceptionally seen. The A/B cells ratio was unchanged in cortisone group,



while in the two other groups the A cells were decreased in number, especially in the smaller islets, and showed hypotrophic changes.

From the foregoing results it appears that impure glucagon in itself cannot be considered as a diabetogenic factor in the intact rat; however, it can potentiate the diabetogenic effect of other hormones, such as cortisone, thus determining a temporary diabetic condition.

It seems that in normal rats the hyperglycaemic effect of glucagon is easily controlled through an extra-secretion of insulin; on the contrary, in cortisone-treated animals, where a high storage of liver glycogen occurs, glucagon can release higher amounts of glucose in the blood stream, thus inducing a relative insulin deficiency. Nevertheless, there are other possibilities for explaining our results: for example, an inhibitory effect either of glucagon or of cortisone on the peripheral utilization of glucose or a direct inhibitory effect on the insulin secretion might be the mechanisms here involved. At present, our knowledge of the physiological activities of glucagon is too slight for giving a complete explanation of the observations.

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Abnormal Accumulation of 3-Hydroxykynurenine in the Mutant 'Aka-Aka' of Silkworm

RECENTLY, Inagami¹ obtained (isolated) a mutant of *Bombyx mori*, proved that it is based upon a single recessive gene and called it 'Aka-Aka' (*rb*), which means red colour in Japanese, for the skin of the mature larva is red and its body fluid turns fairly red when exposed to air in contrast with the blackening of the normal type.

In order to investigate the mechanism of this red colouring we dialysed the body fluid gathered from several larvae of this mutant against diluted acetic acid, and the external dialysate, which showed a strong ultra-violet absorption band and an intensive diazo reaction (red), was concentrated under reduced pressure in an atmosphere of hydrogen. The resultant syrup was chromatographed on No. 50 Töyō filter paper (40 cm. $\times$ 40 cm.) using water-acetic acid-butanol (ascending method), and the chromatogram was observed under ultra-violet light; only one main fluorescent band was detected between R_F values of 0.30 and 0.38. This band was cut out and, after elution with water, we carried out paper-chromatography, colour tests and ultra-violet absorption spectrography with the elute. As indicated below, the substance concerned was shown to be 3-hydroxykynurenine. It gave a green fluorescence, the ninhydrin reaction, a strong diazo reaction (brownish-red, turning slowly to brown), Ehrlich's reaction with aldehyde (pink) and a ferric chloride colour test (brown); R_F in butanol-acetic acid, 0.39; R_F in 70 per cent propanol, 0.31; R_F in benzene-butanol-methanol-water (1:1:2:1), 0.38; absorption maxima (pH 3.0) 270 and 370 μ . The same values as above were obtained with an authentic sample of 3-hydroxykynurenine.

In accordance with the strong diazo reaction of the external dialysate (see above), the estimated value for 3-hydroxykynurenine in the body fluid, which was determined by another method¹, was strikingly high, amounting to 15~20 times as much as that in the White-2 mutant or the normal type.

The abnormal colouring of the 'Aka-Aka' mutant is presumably due to extraordinary accumulation of 3-hydroxykynurenine, for Inagami² could induce the red-colouring by addition of this substance to the dopa-tyrosinase system, differing from the case without addition of 3-hydroxykynurenine (in this case, as is commonly known, the reaction mixture turns black).

We thank Prof. T. Sakan for a gift of 3-hydroxykynurenine.

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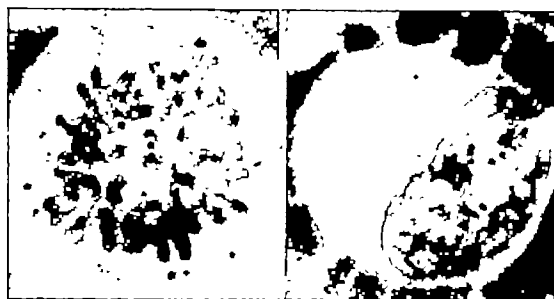
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¹ Inagami, K., and Sudoh, Y., Seventh meeting at the Kyushu-Branch of the Jap. Nutr.-Food Soc. and the Jap. Biochem. Soc., Abstracts of Papers, p. 22 (Kumamoto, 1953).

Detection of Adenine Carbon-14 in Deoxyribonucleic Acid by Autoradiography

THE standard procedure for detecting phosphorus-32 in deoxyribonucleic acid by autoradiography is to hydrolyse the smears or sections in N HCl at 60° C. for 6-10 minutes. The acid hydrolysis removes RNA and most of the non-DNA phosphates.

Adenine carbon-14 administered *in vivo* or *in vitro* will be taken up by both nucleic acids. Since, however, the usual biochemical procedure to isolate the purine bases from the nucleic acid solutions is



Adenine carbon-14 in deoxyribonucleic acid. Human bone-marrow cells cultured *in vitro* for 24 hr. in 0.5 μ Ci/ml. adenine-8-¹⁴C. Smears fixed in alcohol and hydrolysed in N hydrochloric acid, 60° C., 6 min. Stained autoradiographs. ($\times$ 1,400)

acid hydrolysis, the histochemical separation of RNA from DNA is usually performed by ribonuclease.

Current work on the nucleic acid metabolism of human bone marrow cells *in vitro* necessitated the use of adenine-8-carbon-14. Since the RNA turnover was found to be higher in the nucleus than in the cytoplasm, the autoradiograph above the nucleus cannot give even approximate information on the rate of DNA synthesis unless RNA is removed from the cells.

The preparation of ribonuclease is somewhat cumbersome and batches may vary in activity, mainly due to the amount of impurity present in the preparation. The enzyme is sensitive to pH, which also has to be controlled, during incubation of the enzyme, with smears or sections.

In order to find a simple and easily standardized procedure it was decided to investigate the action of acid hydrolysis on DNA adenine in smears. Although the literature described the isolation of purine bases from nucleic acid solutions by acid hydrolysis, no experimental evidence was found that the same effect will occur in alcohol-fixed smears on brief hydrolysis.

Human bone marrow cells were cultured *in vitro* in 0.5 μ Ci/ml. adenine-8-carbon-14 for 12-24 hours. The smears were fixed in 95 per cent alcohol and one batch was treated with ribonuclease (2 mgm./ml. for 2 hr. at 37° C.), the other with N HCl at 60° C. for 6-10 min. The slides were coated, using stripping film, and stained autoradiographs were made, as described elsewhere¹. It was found that in the smears six minutes hydrolysis gives identical pictures to those of the ribonuclease. The grain counting over the nuclei of the acid-hydrolysed or ribonuclease-treated cells indicates an uptake of the order of $10-15 \times 10^4$ carbon-14 atoms in twenty-four hours. Since the total number of DNA adenine + guanine molecules per nucleus is of the order of 0.85×10^{10} this implies a very high degree of labelling of the DNA. More than seven minutes hydrolysis tends to decrease the strength of the autoradiographs; presumably some purine bases are removed from the DNA by prolonged hydrolysis. The application of deoxyribonuclease prior to acid hydrolysis renders the smears completely free from carbon-14 activity.

The photomicrographs illustrate the pictures thus obtained with acid hydrolysis. It is a procedure easy to standardize and has been found a simple method for the autoradiographic determination of DNA adenine.

This work is part of an investigation carried out with a grant from the British Empire Cancer Campaign. Grateful acknowledgment is made to Dr. S. R. Palo, of the Radiopathological Research Unit

of the Medical Research Council, Hammersmith Hospital, for the samples of ribonuclease and deoxyribonuclease.

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Presumed Antitubercular Activity of 4-Amino-6-Hydroxy-*iso*-Phthalic Acid

AMONG the numerous compounds obtained by modifying the chemical molecular structure of *para*-amino-salicylic acid, our attention has been directed to 4-amino-6-hydroxy-*iso*-phthalic acid¹, especially concerning the discordant opinions in respect of its antitubercular activity. In fact, while Bavin *et al.*² have found an activity corresponding to that of the *para*-amino-salicylic acid, according to Beyerman and Alberda³ the compound should be 2-5 times less active than *para*-amino-salicylic acid.

Investigators¹ have generally obtained this compound from *m*-aminophenol by means of a Kolbe reaction. In this reaction the principal product formed is *para*-amino-salicylic acid, while the 4-amino-6-hydroxy-*iso*-phthalic acid has to be isolated as a side-product.

Recently, Beyerman and Wieleaert⁴ have described a synthesis with 4,6-dinitro-*m*-xylene as starting material, and have found the same bacteriological activity as before.

We have synthesized this compound by another route with the view of examining these discrepancies.

For this purpose we nitrated the 1,2,4-xylidine with concentrated sulphuric acid and fuming nitric acid to 4-amino-6-nitro-*m*-xylene (m.p. 123°)⁵, then the NH₂-group was substituted by diazotiation by an OH-group which was transformed into the methyl-ether by suspending the solid sodium compound in xylene and by reacting with dimethylsulphate (yield 63 per cent). The two OH₂-groups were oxidized with KMnO₄ in a current of carbon dioxide (yield 50 per cent). By etherifying, Maltese⁶ has obtained a yield of 25 per cent only, and by oxidizing with KMnO₄ but without carbon dioxide he obtained a mixture of mono- and di-carbonic acids which was scarcely separable. The splitting of the etheral bond has been worked out with hydrogen bromide in acetic acid (glacial) (yield 63 per cent), m.p. 265° (crystallized from water). Calc. for C₉H₇NO₃: C, 42.30; H, 2.22. Found: C, 42.47; H, 2.14.

Successively, the nitro compound has been reduced to an amine with platinum oxide in alcohol; m.p. 212° (crystallized from diluted alcohol). Calc. for C₉H₉NO₃: C, 48.73; H, 3.58; N, 7.10. Found: C, 48.91; H, 3.22; N, 7.16.

For identification, we have transformed the compound into dimethyl 4,6-dimethoxy-*iso*-phthalic acid, as has already been done by Beyerman and Alberda³. This compound had a melting point of 147-148° C., in accordance with the literature⁶.

With the compound so prepared, inhibitory concentrations have been worked out in Youmans's medium with *M. tuberculosis*, strain H₃₇Rv, by inoculating 0.01 mgm. for 1 ml. of medium.

The results, read after fifteen days of incubation at 37°, have shown that for the *para*-amino-salicylic acid the minimal quantity to inhibit the growth is 0.1 mgm./100 ml., while for 4-amino-6-hydroxy-*iso*-phthalic acid it is 5 mgm./100 ml.

Therefore, the compound has been found to be much less active than described in the literature, and for this reason we suppose that other authors have worked with a product which was insufficiently pure and which contained other more active compounds.

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Methyl Proline in Young Apple Fruits

It was recently suggested that a 'new' amino-acid isolated from the apple fruit was a methyl proline¹. This acid (called *D*₁ in the original communication) has now been compared with an authentic specimen of γ-methyl proline kindly supplied by Prof. F. C. Steward, of Cornell University. The positions occupied by these two acids on two-dimensional chromatograms (phenol ammonia-butanol-acetic acid-water) were found to be identical. Mr. J. K. Pollard in Prof. Steward's laboratory has also found the two compounds to superimpose on collidine-lutidine: phenol chromatograms. The two compounds (*D*₁ and γ-methyl proline) give identical colour reactions on paper chromatograms with ninhydrin (a yellow-orange colour) and with isatin (a pure blue colour developing at the same rate with both acids). Not more than ~17 mgm. of *D*₁ were obtained from 70 kgm. of young Worcester Pearmain apples, and elementary analysis on a sample containing traces of inorganic salt gave the following: C, 53.6 per cent; H, 8.17 per cent; N, 9.7 per cent. Assuming this indicates a C₉ compound with an empirical formula of C₉H₁₁O₃N, and correcting the analyses for ash gives: C, 55.8; H, 8.5; N, 10.1; methyl proline requires: C, 55.8; H, 8.5; N, 10.8 per cent.

It has already been shown that this acid is not the isomeric piperidine-2-carboxylic acid². In the Cornell laboratory, using washed and buffered papers, authentic γ-methyl proline was readily separable from pipecolic acid in butanol acetic chromatograms (γ-methyl proline, *R_F* = 0.259; pipecolic acid, *R_F* = 0.214). In the Ditton Laboratory, *D*₁ was not separable from pipecolic acid in butanol-acetic chromatograms. Therefore, this evidence alone is inconclusive. (It was unfortunately not possible to compare *D*₁ with the γ-methyl proline under the Cornell conditions.) The possibility is thus not ruled out that the material *D*₁ is any one of the possible methyl prolines. The constitution suggested by Grassman and von Arnim³ for the blue-coloured compound formed between proline and isatin does not help here since β- and γ-positions in the pyrrolidine rings are not involved.

Circumstances make it unlikely that further quantities of the acid will be obtained from the apple in this Laboratory in the near future; the object of this communication is to stimulate the search for methyl proline in other plant material.

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* Gramman, W., and v. Arnim, K., *Leibigs Ann.*, 519, 192 (1935).

A Histochemical Property of the Argentaffin (Kulschitsky) Cells

BAKER¹ introduced in 1946 a carefully standardized technique, developed from the Smith-Dietrich test, for the detection of lipines. In a later communication² he claimed that this modification (the acid-haematein test), controlled by his pyridine-extraction test, allows histochemical recognition of phospholipines. This was confirmed by Cain³ while working in Baker's laboratory.

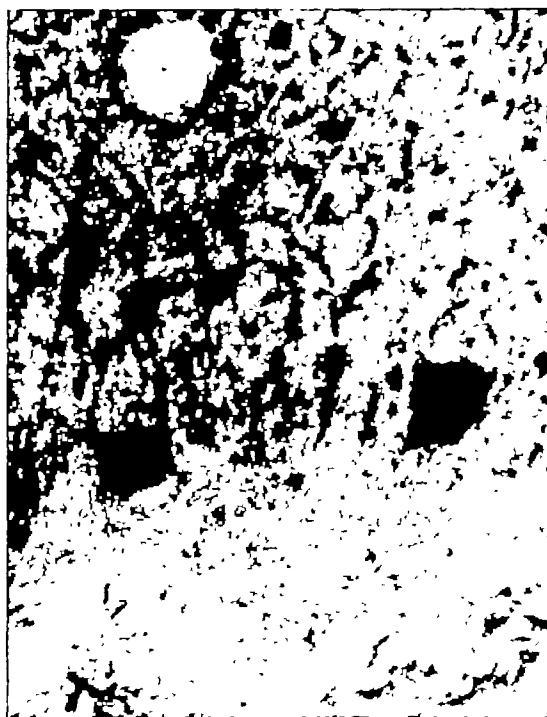
Casselman⁴ applied this technique to certain synthetic enantiomeric α -phosphatidic acids, α -phospholipines, and related compounds, and to highly purified, natural lipine fractions, as well as to an additional 123 other substances: only phospholipines and certain phosphatidic acids gave positive results. His findings, while confirming Baker's claim, also suggested that "the entire phospholipine molecule may not be essential because some phosphatidic acids also give true positive reactions" (that is, positive in the acid-haematein test and negative in the pyridine-extraction test).

In his earlier communication, Baker observed that the Paneth cell granules in mouse intestine gave a positive though "rather weak" reaction which was negative in pyridine-extracted tissue.

In the intestine of two species (man and guinea pig) I have found that the argentaffin cells give a positive reaction with the acid-haematein test and a negative one in the pyridine-extraction test. As is well known, these cells in man are packed with infra-nuclear granules, which reduce solutions of ammoniacal silver nitrate with resulting deposition of silver on them⁵. The accompanying illustration shows such cells in a human appendix stained by Baker's acid-haematein method. (They are unstained in the pyridine-extraction test.)

This test has also been applied to human post-mortem material fixed 1½ hr. after death, with equally successful results. The argentaffin cells in guinea pig intestine likewise give clear-cut positive results.

Sections of gelatin-embedded, formalin-fixed tissue from a surgically removed argentaffin (carcinoid) tumour of the ileum in an elderly male were immersed in cold 5 per cent potassium dichromate-1 per cent calcium chloride solution for eighteen hours, followed by further treatment with this mixture at 60° C. for twenty-five hours, and then treated as directed in Baker's test. Many of the tumour cells grouped in acini about a central lumen, and especially such acini just beneath the stretched, overlying intestinal mucosa showed the characteristic fine infra-nuclear granules reacting positively.



Appendix from a woman aged twenty showing two argentaffin cells stained by Baker's acid-haematein method. ($\times 1,000$)

Sections of this tumour stained by Gomori's⁶ hexamine-silver nitrate method showed that these granules in morphologically similar cells gave the characteristic argentaffin reaction. Although in this latter case the test was not performed strictly according to Baker's specifications, in that sections were cut from gelatin blocks of tissue fixed for several weeks instead of six hours in formal-calcium before chroming, it affords strong presumptive evidence that the characteristic alkaline silver-reducing granules very often seen in the cells of argentaffin tumours also contain a phospholipine.

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Photoelectric Spectrophotometry of Planetary Nebulae

THE electron temperature of a planetary nebula can be determined from the relative intensities of the N_1 and N_2 lines of [OIII] at $\lambda\lambda 5,007, 4,959$, and the 'auroral' type transition at $\lambda 4,363$, provided the target areas for collisional excitation are known¹.

The N_1 and N_2 radiations are usually very much stronger than $\lambda 4,363$. The photographic measurement of the intensity of $\lambda 4,363$ with respect to $H\gamma$ and $H\beta$ is not difficult; but photographic photometry is not

well suited to the measurement of the ratio, R , of the intensity of $N_1 + N_2$ to that of $H\beta$. This is because the ratio is often large, the sensitivity of the emulsion is changing rapidly in the spectral region involved, and the nebular images in the light of hydrogen and [OIII] often show structural differences. Accordingly, a check upon the photographic determinations of this ratio is very much to be desired.

Between May and August 1953 we obtained some photoelectric measures of the ratio R in a number of planetary nebulae using the 24-36-in. Schmidt telescope of the Warner and Swasey Observatory. The objective prism provided a spectral image of each nebula at the focus (97"/mm. and 275 Å./mm. at $H\beta$). An RCA type LP21 photomultiplier tube with associated equipment¹ measured directly the total light intensity in the various spectral images. Details of the procedure for eliminating the effects of overlapping images, spectral sensitivity of the cell, atmospheric extinction, and the stellar continuum will be published elsewhere.

For the five planetaries listed in the first column of Table 1 numerical values for the ratio, R , are given in the second column. The probable errors of R are listed in the third column, and the number of runs over the spectrum of the nebula, n , are given in the fourth. The more precise photoelectric results confirm the accuracy of Aller's photographic measures² given in the last column.

Table 1

NGC	R photoelectric	Probable error	n	R photographic
6,543	8.07	0.14	10	8.1
6,826	9.8	0.2	3	10.7
6,573	15.75	0.13	11	13.9
7,027	20	1	1	18.7
7,662	20.0	1.4	4	21.2

The photoelectric observations provide additional information which is very difficult to obtain by other methods, namely, the intensity of the emission lines in terms of the energy in the continuum of the central star. Results for two planetaries are given in Table 2. For each, the number in the second column is the intensity of N_1 and N_2 combined in terms of the energy per angstrom in the stellar continuum at 45,007.

Table 2

NGC	$N_1 + N_2/\text{cont.}$	Probable error	n
6,826	2,300	140	3
7,662	1,500	60	4

We wish to thank Mr. L. H. Aller for directing our attention to this problem from the observational point of view.

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¹ See, for example, Menzel, D. H., Aller, L. H., and Hobb, M. H., *Astrophys. J.*, **53**, 230 (1941). New values for the target areas have been calculated by Seaton, M. J., *Proc. Roy. Soc., A*, **218**, 400 (1953).

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Fermi's Thermodynamic Theory of the Production of Pions

Fermi's¹ statistical thermodynamic theory of the generation of pions in collisions of high-energy nucleons has stimulated considerable discussion of the problem. The theory is in reasonably good agreement with observation; but the theory is not free, as Fermi himself and others² have pointed out, from conceptual difficulties. However, the purpose of the present note is to show that in the usual derivation¹ for the number of pions produced on Fermi's theory, the contribution of the pions in the lowest energy-state is not adequately taken into account. In fact, because of the Lorentz-contraction of the volume (in which pions are produced) the usual estimate of the total number of pions produced has an appreciable error. In the absence of the Lorentz-contraction the error would be entirely negligible.

Let us consider the sum (in the usual notation):

$$N_1 = \sum_i \frac{1}{e^{\alpha_i - 1}}, \quad \beta = 1/kT. \quad (1)$$

Let N stand for the integral

$$N = \frac{4\pi g \Omega}{(2\pi\hbar)^3} \int_0^\infty \frac{p^2 dp}{e^{\alpha} - 1} = \frac{4\pi g \Omega}{(2\pi\hbar)^3} 2! \frac{\zeta(3)}{\beta^3}, \quad (2)$$

where Ω is the volume of the assembly and g the weight factor for the pions ($g = 3$).

If we write

$$N_1 = N + N_0, \quad (3)$$

then it follows that

$$N_0 = \alpha g kT / \mu c^2, \quad (4)$$

where α is a numerical factor of the order unity. If W is the total energy of the colliding nucleons in the co-ordinate system (called O -system) in which the total momentum is zero, we have, on substituting for (kT) in terms of W :

$$\frac{N_0}{N} = \frac{\alpha [9\pi \zeta(4)]^{1/3} \left(\frac{g\mu}{M}\right)^{1/3}}{2\zeta(3)} \frac{1}{(\gamma f)^{1/3}}, \quad (5)$$

where M is nucleon rest mass, $\gamma = W/Mc^2$, and f is defined by

$$f = \Omega / \bar{\Omega}_0, \quad \bar{\Omega}_0 = \frac{4\pi}{3} (\hbar/\mu c)^3. \quad (6)$$

When $f \sim 1$, $\frac{N_0}{N} \rightarrow 0$ for large γ . However, in Fermi's

theory the volume available in the O -system for production of pions is not $\bar{\Omega}_0$, but the Lorentz-contracted volume $2\bar{\Omega}_0/\gamma$. Hence, we have

$$\frac{N_0}{N} = \alpha \frac{[9\pi \zeta(4)]^{1/3} \left(\frac{g\mu}{2M}\right)^{1/3}}{2\zeta(3)} \sim 0.54 \quad (\text{for } \alpha = \frac{1}{2}). \quad (7)$$

Thus the number N_0 is of the same order as N , and hence Fermi's expression (equation (2)) seriously underestimates the total number of pions produced. In the laboratory system the N_0 pions will form a narrow jet moving along the direction of the incident nucleon, each pion having an energy $\gamma\mu c^2/2$.

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¹ Fermi, E., *Prog. Theor. Phys.*, **5**, 570 (1950); *Phys. Rev.*, **81**, 683 (1951).

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Thermoelectric Power of Cold-worked Copper at Low Temperature

THE influence of cold-working on the thermoelectric power has been measured by a number of workers¹. At room temperature we carried out measurements on copper and silver wires. For a certain amount of cold-working it is found that the relative increase of the absolute thermoelectric power is greater than the relative increase of the resistivity. These results do not agree with the theoretical prediction of T. Hirone and K. Adachi².

So far as we know, no measurements have been carried out at low temperatures.

We measured the thermoelectric force between a wire, drawn at room temperature, and an annealed wire as a function of the temperature of the hot junction. The cold junction was always kept at liquid air temperature (83° K.) (Fig. 1).

Each curve reaches a minimum at a certain temperature which is dependent on the amount of cold-working. At the minimum the thermoelectric power (in 10^{-4} V. per deg. C.) is zero; it is positive above but negative below the corresponding temperature. So the absolute thermoelectric power increases above and decreases below the temperature mentioned.

Fig. 2 shows the temperature of the minimum, shown in Fig. 1, as a function of the percentage reduction of the area of the wire. In the same temperature-range we found cold-worked silver wires always had a positive thermoelectric power relative to annealed material.

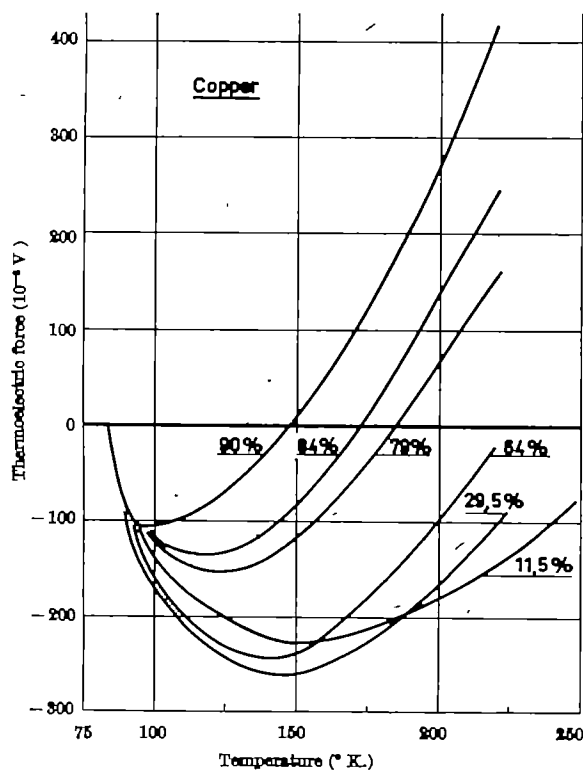


Fig. 1. The thermoelectric force plotted against the temperature of the hot junction for various percentage reductions by drawing. The cold junction is continually kept at 83° K. The thermoelectric force is always measured with respect to the same annealed copper wire.

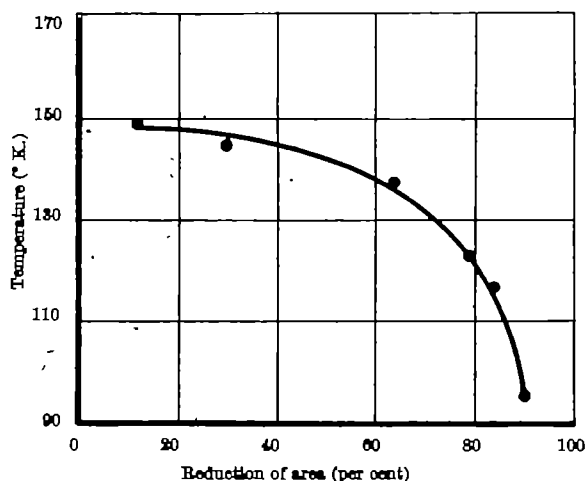


Fig. 2. The temperature of the minimum of a curve of Fig. 1 plotted against the corresponding percentage reduction of the area of the wire.

As usual we call a metal *A* positive with respect to a metal *B* if at the cold-junction the (positive) current flows from *A* to *B*. So far as we know the results for copper do not agree with any theory on the thermoelectric power.

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Delft.
Nov. 11.

¹ For example, Brindley, G. W., Report of a Conference on Strengths of Solids, Bristol, 55 (1948).

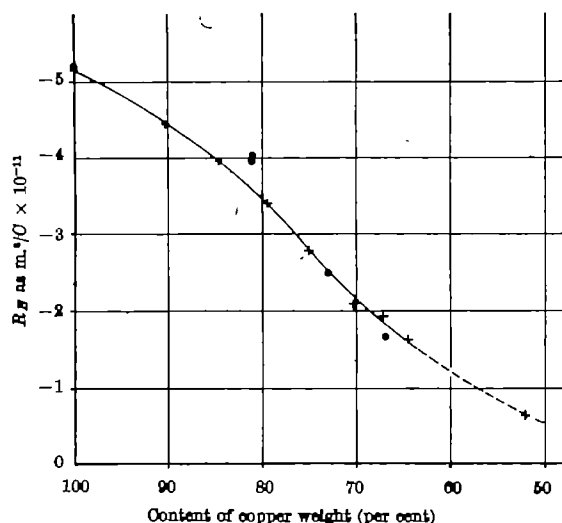
² Hirone, T., and Adachi, K., *Sci. Rep. Res. Inst. Tokyo Univ.*, A, 8, 454 (1951).

Measurement of the Hall Coefficient of α - and β -Brass

THE measurements described herewith were undertaken in order to find out whether any pronounced change in the Hall coefficient takes place when passing from α - to β -brass.

The well-known method employing d.c. was used, and the specimens were cut from thin sheets of brass. Small blocks of the materials were produced from thin copper wire and small pieces of zinc by melting in vacuum in a quartz tube, and the sheets were then produced by rolling from these small blocks. (The specimen of 52 per cent copper was milled down from a cast block.) The rolling was carried out at room temperature; but due to work-hardening after a number of operations, it was found necessary to anneal the work once by heating in an inert atmosphere (nitrogen). The specimens were then cut out in rectangular pieces about 48 mm. by 17 mm. The thickness, measured directly, varied from 0.0778 ± 0.0004 mm. to 0.156 ± 0.0005 mm. The d.c. was applied to the specimens through two circular contacts (2 mm. diam.) placed symmetrically with a distance between centres of 40 mm. To exclude errors due to a fixed current direction, the polarity was reversed now and then.

A correction¹ for the short-circuiting of the Hall field by the contacts for the primary current has



Crosses: Present measurements; lengths of vertical and horizontal branches of the crosses indicate the standard deviations.
 ●, measurements by H. H. Hall

been introduced in the evaluation of the Hall coefficient.

The magnetic field was provided by an electro-magnet and the field-strength was found to vary by not more than 0.3 per cent over the area of the sample. The alteration in the Hall potential, brought about by reversing this magnetic field while the current was kept constant, was measured by means of a highly sensitive galvanometer. A potentiometer was connected to two points (with a distance between them of about 4 mm.) of one of the long edges of the specimen. The galvanometer was connected to the slide and to a point on the other edge of the sample, just opposite the potentiometer. The slide was then moved until no potential difference appeared by reversal of the current in absence of the magnetic field². To minimize thermoelectric forces in this arrangement, all connecting wires as well as the potentiometer wire were taken from the same length of copper wire.

The results of the investigation are plotted in the accompanying diagram, showing the Hall coefficient as a function of the content of copper in the brass. Each point is the result of forty measurements made at 4-8 different d.c. currents (up to 27 amp.), but all with the same magnetic induction (0.646 V./m.² = 6,460 gauss), and the standard deviations are indicated in the diagram. Four points from measurements made by E. H. Hall in 1885³ are also plotted. The composition of the brass was determined by the weight of copper and zinc before melting them together. On account of the annealing the homogeneity of the specimens was high and was found to be satisfactory by chemical analysis of different parts of the brass samples. Thanks are due to Mr. J. Rathlev, for making the analyses.

Down to about 65 per cent copper the alloy can be considered to be pure α -brass. At 52 per cent copper it can be considered to be pure β -brass. It appears that the sign of the Hall coefficient is unaffected by the change from α - to β -brass, in opposition to what might be expected from the theory of H. Jones⁴ for the phase boundaries in binary alloys.

I wish to thank Prof. T. Bjerge and Prof. H. Højgaard Jensen for their interest in this work and for much valuable advice.

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 Copenhagen.
 Dec. 16.

¹ Frank, V., *App. Sci. Res.*, B, 3, 129 (1953).

² Kolláček, F., *Amer. Phys.*, 30, 1491 (1912).

³ Hall, E. H., *Amer. J. Sci.*, 20, 117 (1885).

⁴ Jones, H., *Proc. Phys. Soc.*, 49, 245 (1937).

Direct-Current Corona

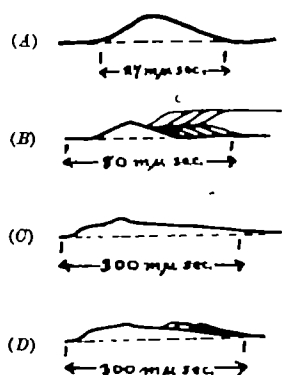
It has previously been reported that the corona in a point-plane gap to which is applied a steady d.c. potential (positive point, negative plane) consists of a series of short-duration pulses^{1,2}, and this had also been observed by me. The results of English¹, who used a photomultiplier to study the light emitted by the corona, show that this light is emitted in the form of pulses of total duration of approximately 6×10^{-8} sec. with "a plateau which gives the impression of two overlapping peaks".

Recently, I have studied the corona for the above-mentioned experimental conditions, using an oscillograph and amplifiers which enable random pulses of a few tens of micro-amperes amplitude and of duration of the order of 10 msec. to be displayed. The current flowing in the gap due to the corona was investigated by inserting a resistor in series with the earthy point and displaying the volt-drop produced across this resistor, after amplification, on the oscillograph. Since the capacitance of the pointed electrode may be made very much smaller than that of the plane electrode, the time-constant associated with the measuring equipment may, by this means, be reduced to a minimum.

For a gap-length of approximately 3 cm. between a platinum wire of 0.005 cm. diameter and an aluminium plane in air at atmospheric pressure, 'noise' is observed from about 9 or 10 kV. upwards. This noise is less than 10 μ amp. mean amplitude and is similar to that seen, for example, on a normal linear sweep. It is unidirectional, increases in amplitude with increasing voltage and vanishes with removal of the voltage from the gap. The measurement by a micro-ammeter of the d.c. current flowing in the pointed electrode gives a value which agrees with the mean level of the noise as seen on the oscillograph, within the limits imposed by the difficulty of calibrating an amplifier with a gain of approximately 30,000 and a band-width of around 100 Mc./sec.

Increase of the applied voltage to about 15 kV. causes the appearance of the pulses which are shown in the accompanying figure (A). The amplitude of these pulses is 2-300 μ amp. peak and their repetition-rate is low, but increases with increasing voltage. Due to the short duration and low repetition-rates of these pulses, their contribution to the current in the gap, as measured by a micro-ammeter, is negligible.

At about 19 kV., the pulse shape is as shown in B, from which it will be seen that most of the pulses are the same as in A; but that a few of them develop a 'plateau' on the back of the pulse. In some cases, this plateau is ended by a fall to zero, but in others the current rises until the amplifiers are saturated. The duration of the plateau is variable.



Reduction of the amplifier gain enables the pulse shape of this rising current to be observed, and this is shown in *C*. The pulses have a peak amplitude of approximately 20 m.amp. and a duration of approximately 0.3 μsec. These pulses are therefore similar in duration to that of the impulse corona²⁻⁴, although the duration of the front of the d.c. corona pulses

appears to be larger than that of the impulse corona.

A further increase of the applied voltage causes secondary pulses to occur on the backs of some of the pulses shown in *C*, and the resultant pulse shape is shown in *D*. At this voltage, occasional spark breakdown may occur.

Visual observation of the gap at the stage when the pulses shown in *C* are present shows that luminosity appears to extend across the whole gap, being confined to a channel of small diameter near the point and spreading out in a fan-shape nearer the plane, and being enhanced by contact with this electrode.

The velocity of propagation of the luminosity has been measured with the aid of a photomultiplier technique⁵, and I find that this luminosity moves from the point to the plane at a constant velocity of approximately 4×10^7 cm./sec. Within the limited range available for investigation to date, this velocity is independent of the gap length. The amount of light emitted by the luminosity as it crosses the gap remains approximately constant, and the extension of the luminosity in the direction of motion, at any instant, appears to be small compared with the gap length.

The small 'bump' on the top of the wave-form shown in *C* appears to coincide with the arrival of the luminosity at the plane.

The duration of the pulses shown in *C* appears to be affected by a change in either the gas pressure or the composition of the gas—a mixture of nitrogen and oxygen.

It should be pointed out that the above phenomena occur without the introduction of any external irradiation, and may therefore be considered to be self-sustaining.

The interpretation of the phenomena described is not yet clear, except possibly in the case of the 'noise'. This cannot be considered as a 'shot-effect' since a current of 8 amp. is required to give an r.m.s. shot-noise current of 10 μamp. for a band-width of 100 Mc./sec. It would therefore appear that the 'noise' is caused by electron avalanches, individual avalanches being subject to statistical variations in the number of component electrons and therefore in

the current produced, and the number of avalanches at any time also being statistically variable.

The amplitudes, durations and repetition-rates of the pulses shown above are such that the measurement of the current in the gap by a d.c. meter is unlikely to give an indication of the existence of the pulses, and therefore any analysis of the breakdown mechanism made solely from such a measurement will probably be false.

Acknowledgment is made to Prof. W. J. John, in whose laboratories this work was carried out, to the I.O.I. Research Committee for the award of a fellowship, and to the London University Grants Committee for a grant for the construction of the apparatus.

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¹ English, W. N., *Phys. Rev.*, **77**, 850 (1950).

² Gaunt, H. M., and Oragga, J. D., *Nature*, **167**, 647 (1951).

³ Davis, R. (private communication).

⁴ Saxe, R. F., and Meek, J. M., *Nature*, **168**, 263 (1948).

⁵ Saxe, R. F., and Meek, J. M. (in preparation).

Abnormalities of Stored Seed

SEEDS of a variety of plants have been stored in unsealed air, sealed air, and carbon dioxide. All have been kept at laboratory temperature for five years. In all cases unsealed seed has deteriorated more rapidly than sealed seed. Furthermore, CO₂-sealed seed has generally given better germination than seeds stored in sealed air. In two varieties of lettuce the original yield of mature plants from sealed seed has been maintained while the plants grown from unsealed seed have a diminished yield (Table 1). Lettuce and onion seeds have been selected for a cytological study because these showed marked differences in deterioration and were suitable material technically.

Chromosomal aberrations in *Crepis* and *Allium* raised from old seed have been reported^{1,2}. We have likewise found gross abnormalities in old lettuce and onion seed; but as with germination, these effects are influenced by the type of storage (see Table 1).

Primary roots were fixed approximately one day after germination, that is, at the end of the period of elongation and at the time that the cells were undergoing their first mitoses. The total anaphase cells were scored from at least five roots from each of the treatments to assess chromosome breakage and mitotic activity. The results are summarized in Figs. 1 and 2.

Examination of metaphase cells in lettuce has revealed that all the breakage is of the chromosome type, that is, it is occurring in the early resting stage before the time of chromosome reproduction, giving

Table 1. PERCENTAGE GERMINATION AND YIELD

		Lettuce variety						Onion
		White Heart (cm)	May Queen (cabbage)	Continuity (cabbage)	Archie King (cabbage)	Black Seeded Bath (cm)	Bedfordshire Champion	
Storage	Unsealed	24 (4)	0	66 (8)	11	20 (3)	2	
	Sealed air	86 (17)	12	91 (8)	65	92 (19)	11	
	Sealed CO ₂	96 (18)	66	96 (9)	56	93 (17)	33	
	Control	97	90	91	94	86	76	

Figures in brackets are mean yields of mature plants in ounces

dicentric but no chromatid interchanges. At anaphase the resulting bridges and fragments are readily observed (Fig. 3).

The lettuce varieties tested show a differing effect of the treatments, and this difference is reflected in breakage, mitotic activity and germination. Although varietal differences occur, the general trend shows a sharp decrease in chromosome abnormalities at high germination values and a corresponding rise in mitotic activity. The onion results, however, differ markedly from the lettuce in revealing a low incidence of breakage at all levels of germination. This shows that in the case of onion, at least, a decrease in germination is not necessarily determined or followed by an increase in the frequency of abnormal cells.

It has been stated that decreased germination and increased chromosome breakage are parallel effects of ageing². The present results clearly show that ageing alone is not responsible for these changes as storage conditions can overcome the effects of age.

Three varieties of lettuce under discussion were grown to maturity in 1953. The diminished yield in White Heart and Black Seeded Bath grown from unsealed seed (as shown in Table 1) was probably due to a reduction in root formation consequent upon the high proportion of abnormal cells present in the primary root.

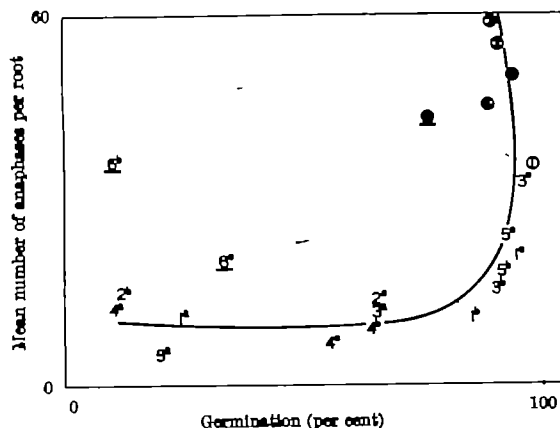


Fig. 1. Relationship between germination and mean number of anaphases per primary root. (The latter used as an index of mitotic activity.) Lettuce varieties: White Heart, May Queen, Continuity, Arctic King and Black Seeded Bath numbered 1-5 respectively. Onion 6. Storage conditions designated as follows: a, unsealed; b, sealed air; c, CO₂-sealed; ringed figures are controls

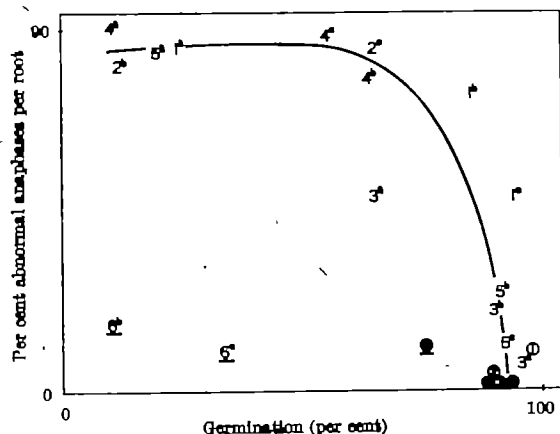


Fig. 2. Relationship between germination and abnormal anaphases in primary root. Key same as Fig. 1



Fig. 3. Abnormal anaphase in a primary root cell of White Heart lettuce 24 hr. after germination of 5-year-old seed. Shows criss-cross separation of a dicentric chromosome and two pairs of acrocentric chromatids. Foulgen squash preparation. ($\times 2,800$)

cells is low they can be readily replaced by active division of normal cells, as has probably occurred in the variety Continuity.

Each of the three groups of plants of Black Seeded Bath grown from sealed and unsealed seed was fertile and produced viable seed. When sown after a short dormancy period each batch of seeds underwent normal germination and the primary roots showed normal mitotic activity with no chromosome abnormality. The gross rearrangements in the parental seedlings were not transmitted to the next generation, but small viable rearrangements may have been perpetuated.

These results show that gaseous exchange plays a large part in the metabolic processes of the resting seed and, in the case of sealed air and carbon dioxide, has counteracted to some extent the effects of age. The effects of ageing upon seeds must, however, be recognized as complex, and the production of cytological abnormalities to be a consequence rather than the initial cause of seed deterioration.

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Dec. 9.

¹ Navaashin, M., *Nature*, 151, 455 (1933).

² Nichols, O., *Amer. J. Bot.*, 29, 755 (1942).

³ Haferkamp, M. H., Smith, L., and Milan, R. A., *Agron. J.*, 434 (1953).

Time of Death of Sex-linked Lethals of Different Origins in *Drosophila melanogaster*

PREVIOUSLY it had been found that the great majority of ultra-violet-induced lethal mutations involving no detectable chromosome changes cause the death of the individual carrying the mutation shortly before or after emergence of the larva from the egg case, or shortly before or after the transformation of the larva into the pupa, while a few caused death just before or after eclosion from the pupa case¹. As an extension of this study it was planned to examine the immature stages of lethals of other origins in order to determine the times when they exerted their deleterious effects.

	Embryonic stages			Larval instars			Pupal stages			Totals
	Early	Middle	Late	1st	2nd	3rd	Early	Middle	Late	
1 Spontaneous lethals	0	0	1	18	0	9	8	0	4	35
2 X-ray-induced lethals	0	0	1	20	0	4	8	0	6	39
3 Ultra-violet-induced lethals (ref. 1)	0	0	7	27	0	9	9	0	3	55

Two groups of lethals were investigated:

(1) Sex-linked lethals which had arisen spontaneously in the female.

(2) Sex-linked lethals which had been induced by irradiation of mature spermatozoa with an X-ray dose of 700 r.

Methods for collecting and examining the immature stages of the lethal-bearing individuals have been described elsewhere¹.

The distribution of lethality is given in the accompanying table.

Two third-instar lethals have been found in the spontaneous group which exhibit melanotic tumours at the time of death, and these are being further investigated.

The clustering of mortality is similar to that found previously for the ultra-violet-induced lethals. Hadorn has found a somewhat similar distribution of the time of death of fifty-nine non-allelic autosomal lethal mutations which arose spontaneously or had been induced by the chemicals phenol or sulphuraphen². The X-ray-induced lethals used, all of which were studied cytologically, were found to involve no detectable chromosomal aberrations³ and the spontaneous lethals, although not examined cytologically, probably also represent point mutations. Thus the finding of a similar distribution as to the time when these lethals and those produced by ultra-violet radiation exert their detrimental effects lends further support to our earlier interpretation that lethal point mutations exert their killing effect usually during the stages when many physiological functions new to the individual come into active operation for the first time in its life.

This work was supported by a grant from the U.S. Atomic Energy Commission.

I wish to express my appreciation to Dr. H. J. Muller for his interest and many helpful suggestions during the course of this work.

IRWIN I. OSTER

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Bloomington, Indiana.
Dec. 17.

¹ Oster, I. I., *Heredity*, **8**, 403 (1953).

² Hadorn, H., *Zwölfter Jahresbericht der Schweizerischen Gesellschaft für Vererbungslehre: Société Suisse de Génétique* (S.S.G.), 147 (1953).

³ Valencia, J. I., *Rec. Genet. Soc. Amer.*, **31**, 77; *Genetics*, **37**, 633 (1952).

Heat Therapy of Virus-Infected Raspberries

Of the various techniques claimed to effect cure of virus-infected plants, only those involving heat treatments of plant material have given consistent results. Warm water treatments and exposure to high air temperature have been used by a number of workers to free plants from certain virus diseases, including raspberries infected with *Rubus stunt*¹.

The purpose of this communication is to describe a method that has been used successfully for freeing raspberries from certain aphid-transmitted viruses

which differ from *Rubus stunt*. Material for treatment was drawn from virus-tested stocks of Norfolk Giant infected with leaf mottle virus, Malling Jewel with a mixture of viruses including leaf spot, and Malling Promise and Lloyd George (New Zealand stock) each infected with unidentified latent viruses^{2,3}. Dipping whole canes and root cuttings in water at temperatures ranging from 35° C. to 50° C. for periods up to two hours failed to effect a cure. But in 1952 virus-free plants of Lloyd George and Malling Jewel were obtained by subjecting growing plants to an air temperature of 32° C. for periods of one to four weeks. After the treatments terminated, the plants were grafted to healthy plants of *Rubus henryi*, a species which is hypersensitive to infection with any of the known raspberry viruses⁴. Absence of symptoms in *R. henryi* is at present assumed to imply freedom from virus in the plant tested. The plants surviving from the first trials have twice been so tested and are still virus-free.

Since then the technique has been improved, and virus-free plants of all four varieties listed above have been obtained. Experiments were begun in June 1953 and are still continuing. Strongly growing plants in 5-in. pots were first defoliated and then peaked in trays of damp peat moss and transferred to a square box of side 3 ft., electrically heated and thermostatically controlled to $\pm 0.5^\circ$ C. Humidity was maintained by daily watering of the pots and peat, and light was supplied for seventeen hours daily by a 400-W. mercury-vapour lamp fitted over the roof of the box. Large plants were pruned to accommodate them more readily into the box. The apparatus was kept in a room not subject to marked temperature fluctuations.

During the first experiment the air temperature was maintained at 32° C. and successive batches of four plants of each of the varieties Norfolk Giant, Lloyd George, Malling Promise and Malling Jewel were exposed for 8, 10, 12, 16 and 20 days. All the plants survived. From the three lots of sixteen plants treated for 8, 10 and 12 days respectively, three, eight and five virus-free plants have so far been recovered; the results of the longer treatments are not yet known. In a second experiment the temperature was raised to 35° C. and the plants, then approaching dormancy, were cut down to about 6 in. After a few days treatment, young shoots appeared, and these continued to grow normally during the experiment. Again, all the plants survived for periods of up to 16 days; but the treatments terminated too late in the season for graft testing to be carried out.

No cures were effected in one earlier trial where plants were exposed for four days at 32° C., and the results so far suggest that exposures longer than eight days are necessary to give a high proportion of cures. The data are insufficient to establish whether there are differences in the resistance to heat treatment among the viruses present in the raspberry plants used, but this is being investigated.

Provided that heat-treated raspberry plants are not altered in other and more detrimental ways than in being freed from virus infection, the potentialities

of this technique for the ready production and maintenance of virus-free oenas are obvious.

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Scottish Horticultural Research Institute,
Mylnafield, Invergowrie,
By Dundee. Dec. 3.

¹Thung, T. H., *Meded. Dir. Tuinb.*, 15, 714 (1952).

²Cadman, C. H., *Ann. App. Biol.*, 38, 801 (1951).

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Cuticles of Erupted Teeth

It is generally agreed that Nasmyth's membrane, which is present on the enamel surface of recently erupted teeth, is composed of an outer cellular and an inner structureless layer, and that shortly after eruption the cells are lost due to degeneration and masticatory trauma. Whether or not the inner structureless layer remains on the surface is a matter of controversy, but it may be inferred from recent papers that it does remain throughout life¹⁻³. This, however, is difficult to envisage in view of the findings of Scott *et al.*⁴ and Scott⁵, who have demonstrated the wear which takes place continually on the enamel surface of erupted teeth, although it is true that these authors do speak of a 'cuticle'.

On the other hand, Manly⁶, Vallotton⁷ and Atkinson⁸ have reported the formation of an amorphous membranous deposit on the enamel surface of erupted teeth. This suggests the possibility of confusion between two membranes of differing origin.

In agreement with Atkinson's findings an amorphous cuticle, resembling in appearance the inner structureless layer of Nasmyth's membrane, has been recovered from areas of enamel attrition as well as from the remaining enamel surface. However, on close examination two differences were observed. First, only the inner layer of Nasmyth's membrane exhibits interference phenomena, and secondly, this layer is marked by outcrops of the enamel prism ends grouped in lines typical of the unworn enamel surface, whereas the cuticle present on older erupted teeth is marked either faintly or not at all. Furthermore, the two membranes differ chemically. The cuticle of erupted teeth is more stable in strong acid at room temperature, and at boiling point it forms 'humin'. This, together with the positive reactions obtained with protein and carbohydrate tests, may indicate that the cuticle contains both these substances in combination. The nature of this combination is indicated by metachromatic staining with toluidine blue and by a positive periodic acid-Schiff reaction, suggesting that the cuticle may contain a mucoprotein. Lipoid is also demonstrable using sudan B.

In consequence of these observations, a series of experiments was carried out using the crown of a 'normal' caries-free tooth extracted from an adult. After removal of the cuticle by immersion in acid the tooth was fitted to a partial denture. This denture was worn in the mouth for periods varying from 7 to 63 days. At the end of each period a cuticle, which in all respects resembled the naturally occurring structure on the enamel of adult erupted teeth, was removed from the crown surface. It is interesting to note that this occurred in spite of the fact that some features of a vital tooth, such as those concerned with enamel permeability, were absent. Atkinson and Prophet⁸ suggested that substances from the saliva might be involved in the formation of 'crack lamellae'.

In the present investigation the naturally occurring cuticle is found to be connected with such lamellae, which show the same properties chemically (in contrast with developmental lamellae obtained from unerupted teeth).

From these observations it appears evident that what in the past has been identified on adult erupted teeth as the inner structureless layer of Nasmyth's membrane has, in fact, been a cuticle formed, and capable of re-formation, after eruption. Bacteria are not found to be constituents of the cuticle.

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Turner Dental School,

University of Manchester. Jan. 15.

¹Darling, A. L., *Proc. Roy. Soc. Med.*, 35, 499 (1942).

²de Fazio, R., *Le Stomatologie*, 2, 245 (1947).

³Hodson, J. J., *Brit. Dent. J.*, 87, 167 (1949).

⁴Scott, D. B., and Wyckoff, R. W. G., *J. Amer. Dent. Assoc.*, 50, 275 (1949).

⁵Scott, D. B., *Oral Surg.*, 5, 638 (1952).

⁶Manly, R. E., *J. Dent. Res.*, 23, 479 (1942).

⁷Vallotton, G. F., *J. Dent. Res.*, 24, 161 (1945).

⁸Atkinson, H. F., thesis, University of Manchester (1950).

⁹Atkinson, H. F., and Prophet, A. S., *Brit. Dent. J.*, 95, 60 (1953).

Divergence in Helical Polypeptide Chains and in Phyllotaxis

In the α -form of synthetic polypeptide chains (poly-L-alanine, poly- γ -methyl-L-glutamate) divergences of the individual amino-acid residues of 5/18, 8/29 or 13/47 corresponding to helix periods of 27 Å, 43 Å, or 70.4 Å, are discussed^{1,2}. The numerators of these figures remind one of the divergences of phyllotaxis, where 5/13, 8/21 and 13/34 are members of the

$$\text{phyllotaxis sequence } \frac{1}{2} \frac{1}{3} \frac{2}{5} \frac{3}{8} \frac{5}{13} \frac{8}{21} \frac{13}{34} \dots$$

In this sequence the numerator and the denominator of every member is the sum of those of the two preceding members. Since this regularity applies also to the divergences discussed for the α -polypeptide helices, an extrapolation to hypothetical lower members of a similar sequence is possible. As a result the following

$$\text{helix sequence } \left(\frac{1}{3} \frac{1}{4} \frac{2}{7} \frac{3}{11} \right) \frac{5}{18} \frac{8}{29} \frac{13}{47} \dots$$

is obtained. It is possible that higher members of this sequence might have a practical significance for polypeptide helices with long-range periods higher than 70.4 Å. The lower extrapolated members, between brackets, have probably no real meaning; they are only mentioned to show that the discussed divergences are members of a very striking sequence, comparable to that in phyllotaxis.

The similarity is certainly due to the same geometrical cause, that is, as dense as possible an arrangement of identical objects along a helix. In the case of phyllotaxis these objects are the protuberances of the young leaves on the growing point in a bud, and in that of the polypeptide helices the amino-acid residues in the crystal lattice.

A. FRÉDY-WYBELLING

Department of General Botany,
Swiss Federal Institute of Technology,
Zurich. Jan. 7.

¹Bamford, G. H., Brown, L., Elliott, A., Hanby, W. H., and Trotter, L. F., *Nature*, 173, 27 (1954).

²Pauling, L., and Corey, R. B., *Nature*, 171, 50 (1953), and 12 5/45 which is nearly 13/47.

FORTHCOMING EVENTS

(Meeting marked with an asterisk * is open to the public)

Monday, March 29

PHYSICAL SOCIETY, ACOUSTICS GROUP (at the Royal Society of Arts, 6 John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Annual General Meeting. 6 p.m.—Mr. W. H. Tait: "Double Reeds: a Note on Their Design and Methods of Making Them".*

Tuesday, March 30

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Sir Arthur Pomitt, K.O.M.G.: "Social Medicine in Australia and New Zealand".

SOCIETY OF INSTRUMENT TECHNOLOGY (at Mansion House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. E. S. Cardale: "Automatic Control in the Iron and Steel Industry".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. D. W. Holder: "Interaction between Shock Waves and Boundary Layers and its Importance in High-Speed Flight".

Tuesday, March 30—Thursday, April 1

PHYSICAL SOCIETY (in the Department of Physics, University College, Dublin)—Spring Meeting—"High Energy Accelerators and Cosmic Rays".

Wednesday, March 31

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Mr. R. Hanbury Brown: "Radio Astronomy".

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the CHEMICAL POLYTECHNIC SOCIETY, at Chelsea Polytechnic, Madres Road, London, S.W.3), at 7 p.m.—Mr. W. M. Lewis: "Science in Criminal Investigation".

Wednesday, March 31—Friday, April 2

CHEMICAL SOCIETY (at the University, Manchester)—Anniversary Meetings.

Wednesday, March 31

10.30 a.m.—Symposium on "Dynamic Stereochemistry".

Thursday, April 1

11.30 a.m.—Prof. H. J. Emeléus, F.R.S.: "Organometallic Compounds containing Fluorocarbon Radicals" (Liversidge Lecture).

Friday, April 2

11 a.m.—Presidential Address by Prof. O. K. Ingold, F.R.S.

Thursday, April 1

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. D. W. Henderson: "The Work of the Microbiological Research Department".

AGRIC (at the Royal Society of Arts, 8 John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Dr. Richard Offer: "History of the Inter-University Council for Higher Education in the Colonies".

INSTITUTE OF METALS, LONDON LOCAL SECTION (at 4 Grosvenor Gardens, London, S.W.1), at 6 p.m.—Annual General Meeting, followed by Discussion on "The Brittle Fracture of Metals".

Thursday, April 1—Monday, April 5

BRITISH PSYCHOLOGICAL SOCIETY (at the University, Nottingham).—Annual Conference.

Friday, April 2

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Annual General Meeting; at 7.30 p.m.—Dr. D. S. Morris: "Chloramphenicol".

ROYAL INSTITUTE (at 21 Albemarle Street, London, W.1), at 9 p.m.—The Right Hon. Lord Rothschild, F.R.S.: "Spermatozoa".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN AGRICULTURAL BOTANY—The Secretary of University Court, The University, Glasgow (March 31).

ASSISTANT LECTURER (with a degree in agriculture or equivalent qualification, and sound experience in practical work, and, if possible, in teaching) in AGRICULTURE, at the Cumberland and Westmorland Farm School, Newton Riggs, near Penrith—The Director of Education, 5 Portland Square, Carlisle (April 3).

LECTURER IN ORGANIC CHEMISTRY, a LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY, an ASSISTANT (Grade B) IN PHYSICS, an ASSISTANT (Grade B) IN BIOLOGY, and an ASSISTANT (Grade B) IN CHEMISTRY, at Birkhead Technical College—The Director of Education, Education Offices, 63 Hamilton Square, Birkhead (April 3).

ENGINEERS (3) (with first- or second-class honours engineering degree (civil or mechanical)) in the Department of Scientific and Industrial Research, Forest Products Research Laboratory, Prince

Harborough, Bucks, for investigations on timber strength, wood sawing and machining—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.99/54A (April 3).

LECTURER (with good university degree or equivalent, and with considerable teaching and industrial or research experience) in AIRCRAFT STRUCTURES, to teach subject to final B.Sc. and H.N.O. standard—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (April 3).

MATHEMATICIAN (with at least H.S.C. (science) or equivalent) at the Ministry of Supply Guided Weapons Establishment, Aberporth, South Wales, to undertake responsibility for film reading and computation section, including interpretation of records, and investigation of new and modified analysis techniques—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.58/54A (April 3).

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with first- or second-class honours degree or equivalent qualification, in physics, chemistry or metallurgy), for development work on carbon for nuclear reactors, involving structural studies of porous solids—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berkshire, quoting 2/103/70 (April 3).

EXPERIMENTAL OFFICER, Grade III (with degree or diploma in engineering, or equivalent qualifications, and several years experience in wind tunnel investigations related to aircraft or missile development) in the Department of Supply, Aeronautical Research Laboratories, Fishermen's Bend, Victoria, Australia, to carry out wind tunnel investigations related to the development of new aircraft and missile types—The Senior Representative (AP.11), Department of Supply, Australia House, Strand, London, W.C.2 (April 5).

PRINCIPAL SCIENTIFIC OFFICER (Supersonic Theory) (with a degree of high standard in mathematics, and extensive experience of theoretical work in supersonic aerodynamics and ability to direct the work of others) in THE HIGH SPEED AERODYNAMICS LABORATORY, Department of Supply, Salisbury, South Australia, to initiate and be responsible for research, especially of a mathematical nature, in supersonic and transonic flow; and to exercise supervision over the work of other scientific staff and of a small computing "pool"—The Senior Representative (A.P.10), Department of Supply, Australia House, Strand, London, W.C.2 (April 5).

PHYSICIST or CHEMIST, Principal Scientific Officer grade (with first- or second-class honours degree or equivalent in physics or chemistry, and considerable research and development experience in the field of high polymers, particularly natural and synthetic rubbers) at the London Headquarters of the Ministry of Supply, for duties which will include initiation and progressing of research and development work on rubbers for Service purposes, and advice to Service Departments on technical applications of rubber—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.183/54A (April 10).

SENIOR LECTURER IN GEOGRAPHY at the Fourth Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (April 12).

PHYSICAL CHEMIST (with a first- or second-class honours degree in physical chemistry or equivalent qualifications, and preferably with previous experience of chemistry of plastics and polymers) at the National Coal Board, Stoke Orchard, near Cheltenham, for work on chemical and physical changes in coal during carbonization—The National Coal Board, Central Research Establishment, Stoke Orchard, near Cheltenham, Glos, quoting TT/751 (April 15).

BRITISH COKE RESEARCH ASSOCIATION FELLOW (honours graduate in chemistry, physics, or applied science related to fuel technology), to work on the physical chemistry of carbon, under the direction of the Professor of Physical Chemistry—The Registrar, King's College, Newcastle-upon-Tyne (April 19).

ASSISTANT LECTURER (3) in PSYCHOLOGY—The Registrar, The University, Manchester (April 21).

SENIOR LECTURER IN PHYSICS—The Registrar, The University, Sheffield (April 21).

ASSISTANT LECTURER IN THE DEPARTMENT OF BIOCHEMISTRY—The Secretary, University College London, Gower Street, London, W.C.1 (April 22).

LECTURER, Grade II (with a degree in metallurgy, engineering or related science), in INDUSTRIAL METALLURGY—The Registrar, The University, Edgbaston, Birmingham 15 (April 30).

LECTURER or ASSISTANT LECTURER in ORGANIC CHEMISTRY at the University College of North Staffordshire—The Registrar, The College, Keele, Staffs (April 30).

MYCOLOGIST in THE PLANT PATHOLOGY DEPARTMENT—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (April 30).

RESEARCH FELLOW IN PURE SCIENCE at the University of Durham—The Secretary, University of Durham, 38 North Bailey, Durham (April 30).

SENIOR and JUNIOR RESEARCH FELLOWS (with first- or second-class honours degree in an appropriate subject, and able to show evidence of a very high standard of ability in research) in Government Scientific Establishments, for research into subjects of importance to H.M. Government—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4300/54 (April 30).

UNIVERSITY LECTURERS or UNIVERSITY DEMONSTRATORS at THE FACULTY OF ENGINEERING, University of Cambridge—The Secretary of the Appointments Committee, Engineering Laboratory, Cambridge (April 30).

ASSISTANT LECTURER IN PURE MATHEMATICS—The Registrar, University College, Hull (May 1).

RESEARCH STUDENTSHIP in CHEMICAL ENGINEERING tenable in the Department of Chemical Engineering, University of Cambridge—The Secretary, Department of Chemical Engineering, Tennis Court Road, Cambridge (May 1).

LECTURER in SOCIAL ANTHROPOLOGY—The Registrar, King's College, Newcastle-upon-Tyne (May 1).

PROFESSOR OF PHYSICS at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, May 1).

SENIOR RESEARCH OFFICERS (3) (preferably with specialized post-graduate training in a branch of science applied to agriculture) to take charge of sugar cane research in the main ecological divisions of the sugar cane area—The Director of Research, Sugar Research Department, Mandeville, Jamaica, British West Indies (May 7).

LINCOLN IN PHYSICS at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, May 10).

RESEARCH RESEARCH FELLOWS (3) (graduates of British universities) for research in chemistry or physics—The Registrar, The University, Sheffield (June 1).

LINCOLN (with a good honours degree in botany and research experience, preferably in genetics) in BOTANY, at the Imperial College of Tropical Agriculture, Trinidad, British West Indies—The Secretary, The Imperial College of Tropical Agriculture, 40 Norfolk Street, Strand, London, W.C.2 (June 30).

ASSISTANT LINCOLN, Grade B (with a good honours degree in physics or electrical engineering, and some research, industrial or teaching experience) in THE DEPARTMENT OF APPLIED PHYSICS AND ELECTRICAL ENGINEERING, College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff.

BIOCHEMIST (with at least a good second-class honours degree, with appropriate postgraduate experience) at the West African Fisheries Research Institute, Sierra Leone—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODL197/194/01.

GEOLOGIST (with second-class honours degree, Division 1, in geology, or equivalent) in the Gold Coast Civil Service, for geological mapping, investigation of mineral deposits and water supplies, etc.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODL105/13/07.

ORGANIC CHEMIST for fundamental research on the chemistry of cellulose and its derivatives, a CHEMIST (with a leaning towards physical and/or analytical chemistry) for fundamental research in cellulose chemistry, a PHYSICAL CHEMIST to study the degree of polymerization of macromolecular substances, with ultra-centrifuge, etc., a CHEMIST or PHYSICIST (with a knowledge of X-ray crystallography) for research on the structure of textile fibres, a CHEMIST (with experience in infra-red spectroscopic techniques) for research on the structure of textile fibres and on the mechanism of dyeing, a CHEMIST for fundamental and technical research on the bleaching of textiles, and a CHEMIST for fundamental and technical research on the chemical finishing of textiles, with the British Cotton Industry Research Association—Dr. F. C. Toy, Director of Research, Shirley Institute, Didbury, Manchester 20.

PHYSICISTS (with good honours degree, and with some experience or training in research, not necessarily textile research) for work on textile problems—The Secretary, British Rayon Research Association, Barton Dock Road, Urnston, Manchester.

PRINCIPAL SCIENTIFIC OFFICERS (with at least a second-class honours degree in physics or engineering, and with three years post-graduate research experience, and a knowledge of fluid dynamics) at the Department of Atomic Energy, Copenhagen, near Chester, as project leaders on engineering physics problems connected with gaseous diffusion plant and power reactors—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 568.

PROTOZOOLOGIST (with a medical or veterinary degree or diploma registrable in the United Kingdom, and two years postgraduate research experience, and a sound knowledge of protozoology) at the East Africa Tsetse and Trypanosomiasis Research and Reclamation Organisation, to undertake research in the human and animal trypanosomiasis—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting ODL196/196/01.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Agriculture and Fisheries. Report of the Working Party on Agricultural Education. Pp. 20. (London: H.M. Stationery Office, 1953.) 9d. net.

Microbes and Antimicrobial Agents in Vitro Microbiological Assay. (Paper Discs for use in Bacterial Sensitivity Tests.) Pp. 20. (Poole: British Drug Houses, Ltd., 1953.)

The Manchester Museum. The University, Manchester. Report 1952-1953. Pp. 24. (Manchester: Manchester Museum, 1954.)

Current Chemical Papers. 1954. No. 1. Pp. 44. (London: The Chemical Society, 1954.)

Proceedings of The Royal Society of Edinburgh. Series A (Mathematics). Vol. 64, Part 1 (No. 2): Asymptotic Renewal Theorems. By Walter L. Smith. Pp. 9-48. 6s. 9d. Vol. 64, Part 1 (No. 3): The Problem of Two Bodies in Whitehead's Theory. By Dr. G. L. Clark. Pp. 49-56. 1s. 2d. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.)

University of Cambridge: School of Agriculture Memoirs. Memoir No. 25: A summary of the papers published by the members of the Staff of the School of Agriculture and its Associated Research Organizations during the period Oct. 1st, 1952—Sept. 30th, 1953. Review Series No. 8: Animal Production Research at Cambridge. By Dr. John Hammond, F.R.S. Pp. 31. (Cambridge: University of Cambridge, School of Agriculture, 1954.) 2s. 6d.

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the year 1953. West Midland and Southern Division. By H. S. B. Scott. Pp. 11+20. (London: H.M. Stationery Office, 1954.) 1s. net.

University of London. University College Annual Report 1953-1954. Pp. 92. (London: University of London, 1954.)

Other Countries

Transactions of the National Institute of Sciences of India. Vol. 3, No. 5: Gaseous Reduction of Iron Ore. By Dr. H. Trivedi. Pp. 211-256. (New Delhi: Manager of Publications, 1953.) 3 rupees. Centre National de la Recherche Scientifique. Centre d'Etudes Mathématiques en vue des Applications. Monographies. O: Physique Mathématique, 2: Les fonctions orthogonales dans les problèmes aux limites de la physique mathématique. Par Theodores Vogel. Pp. 103+4. (Paris: Editions du Centre National de la Recherche Scientifique, 1953.) 1200 francs.

Les applications de la mécanique ondulatoire à l'étude de la structure des molécules. Réunions d'études et de mises au point, tenues sous la présidence de Louis de Broglie. Pp. 224+2 plates. (Paris: Editions de la Revue d'Optique et d'Instrumentation, 1953.) 1600 francs.

Department of Scientific and Industrial Research, New Zealand. The Dominion Laboratory. Pp. 32 (13 plates). (Wellington, N.Z.: Department of Scientific and Industrial Research, 1953.)

The Use of Aircraft in Agriculture in the U.S.A. (Technical Assistance Mission No. 107.) Pp. 106. (Paris: Organisation for European Economic Co-operation, 1953.)

Det Norske Videnskaps-Akademii i Oslo. Astrophysica Norvegica. Vol. 5, No. 3: On the Formation of Surface Waves in a Fluid Flowing over a Corrugated Bed and on the Development of Mountain Waves by Black Palm. Pp. 61-130. (Oslo: Jacob Dybwad, 1953.)

Smithsonian Institution. Proceedings of the United States National Museum. Vol. 103, No. 3322: The Fresh-Water Trilobites (Trilobellaria) of Alaska. By Roman Kenk. Pp. 163-186+plates 6-8. (Washington, D.C.: Government Printing Office, 1953.)

U.S. Department of Agriculture. Farmer's Bulletin No. 1651: The Corn Harvest as an Index of Field Corn in the Western States. By R. A. Blanchard and W. A. Douglas. Pp. 16. (Washington, D.C.: Government Printing Office, 1953.) 10 cents.

Bulletins de la Société Royale de Zoologie d'Anvers. No. 1: 1. Infections à Plasmodium chez les Pinguins. Par Dr. J. Rodhe. Pp. 24 (4 plates). No. 2: Les Poissons d'Aquarium du Congo Belge. Par Dr. Max Poll. Pp. 43 (23 plates). No. 3: Les Facteurs Physiopathologiques Influençant l'Acclimatation de l'Okapi. Par Dr. L. M. G. Geurden. Aperçu Succinct de nos Communes Actuelles au sujet de l'Okapi. Par Dr. A. Vandermander. L'Acclimatation des Okapis à Londres et Copenhagen. (Extraits de rapports de M.M. O. S. Webb, Curator of Mammals and Birds, Zoological Society of London, et Axel Reventlow, Adm. Director, Zool. Havn København. Pp. 54 (11 plates). (Anvers: Société Royale de Zoologie d'Anvers, 1953.)

Sudan Government. Wellcome Chemical Laboratories, Medical Services, Ministry of Health, Khartoum. Report of the Government Analyst for the period 1.7.1952-30.6.1953. Pp. 24. (Khartoum: Ministry of Health, 1953.)

Imperial College of Tropical Agriculture. A Report on Ode Research, 1952. Pp. 72. (St. Augustine, Trinidad and London: Imperial College of Tropical Agriculture, 1953.) 8s.

Organisation for European Economic Co-operation. Summary of the First Annual Programme of Action of the European Productivity Agency. Pp. 18. (Paris: Organisation for European Economic Co-operation, 1954.)

Institute for Weather and Climate Research. The Norwegian Academy of Sciences and Letters. Publication No. 1, 1953: Two-Dimensional Perturbation of a Flow with Constant Shear of a Stratified Fluid. By A. Håssan, H. Høiland and H. Rie. Pp. 80. Publication No. 2, 1953: A Statistical Discussion of a Possible Connection Between Solar Activity and Sea-Level Pressure. By Jack Nord. Pp. 42. (Bilthoven-Oslo: Institute of Theoretical Astrophysics, 1953.)

State of California: Department of Fish and Game. Marine Research Committee. Progress Report, 1 July 1952 to 30 June 1953. Pp. 44. (Terminal Island, Calif.: State Fisheries Laboratory, 1953.)

Berichte des Deutschen Wetterdienstes. Nr. 6: Klimatologische Studie über die Temperaturverhältnisse der Grosswetterlagen Mittel Europas am Beispiel von Karlsruhe und Bremen. Von Dr. Kur Burger. Pp. 46. Nr. 7: Statistische Untersuchungen über die Zirkulation der Westdrift in 55° Breite. Von Dr. Oskar Rosenwanger. Pp. 22. 2.90 D. marks. Nr. 8: Über die Messung des Luftdruckes durch Bestimmung der Staudtemperatur mit dem Hypsometer. Von Dr. Hans Gerhard Müller. Pp. 14. (Bad Kissingen: Deutsche Wetterdienstes, 1953 and 1954.)

Proceedings of the Kjeller Conference on Heavy Water Reactor Organized by the Joint Establishment for Nuclear Energy Research held at Kjeller and Oslo, August 11th to 13th 1953. Edited by J. Goedkoop and G. Janssen. (No. 7, JENNER Publication.) Pp. xi+23. (Kjeller per Järestrom: Joint Establishment for Nuclear Energy Research, 1953.) 35 kroner.

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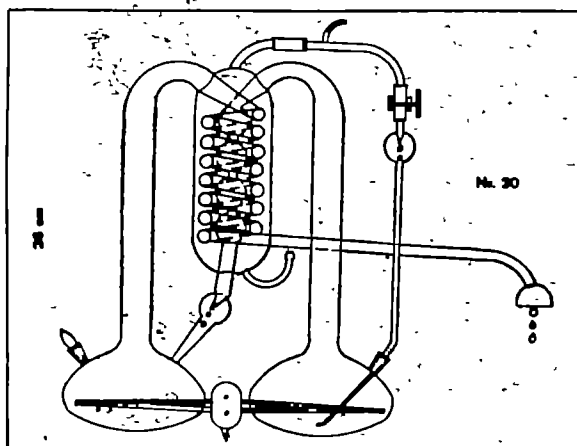
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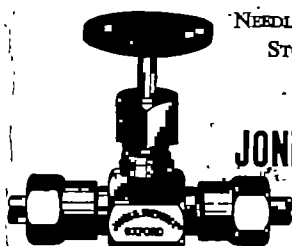
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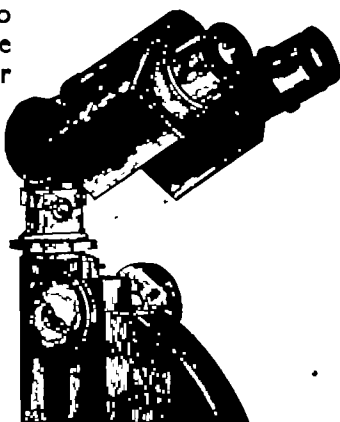
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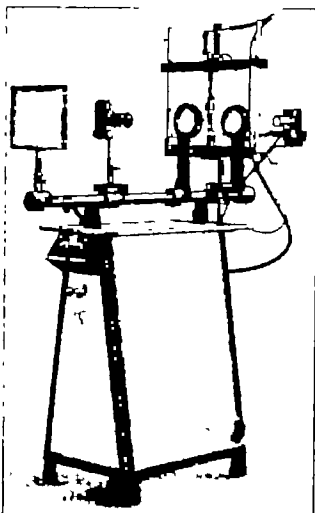
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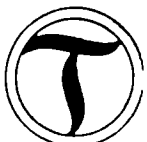
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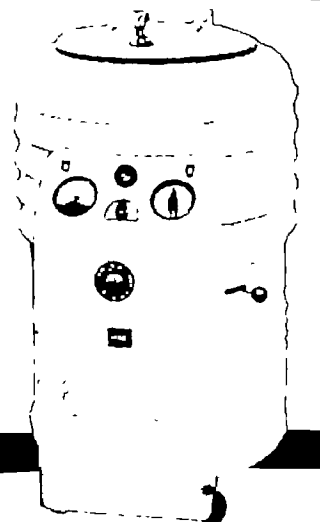
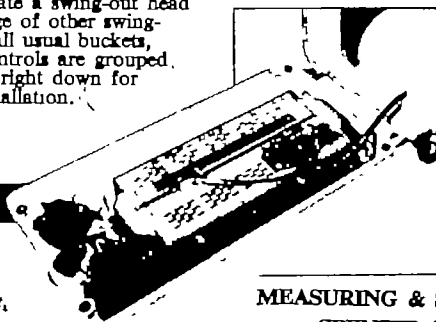
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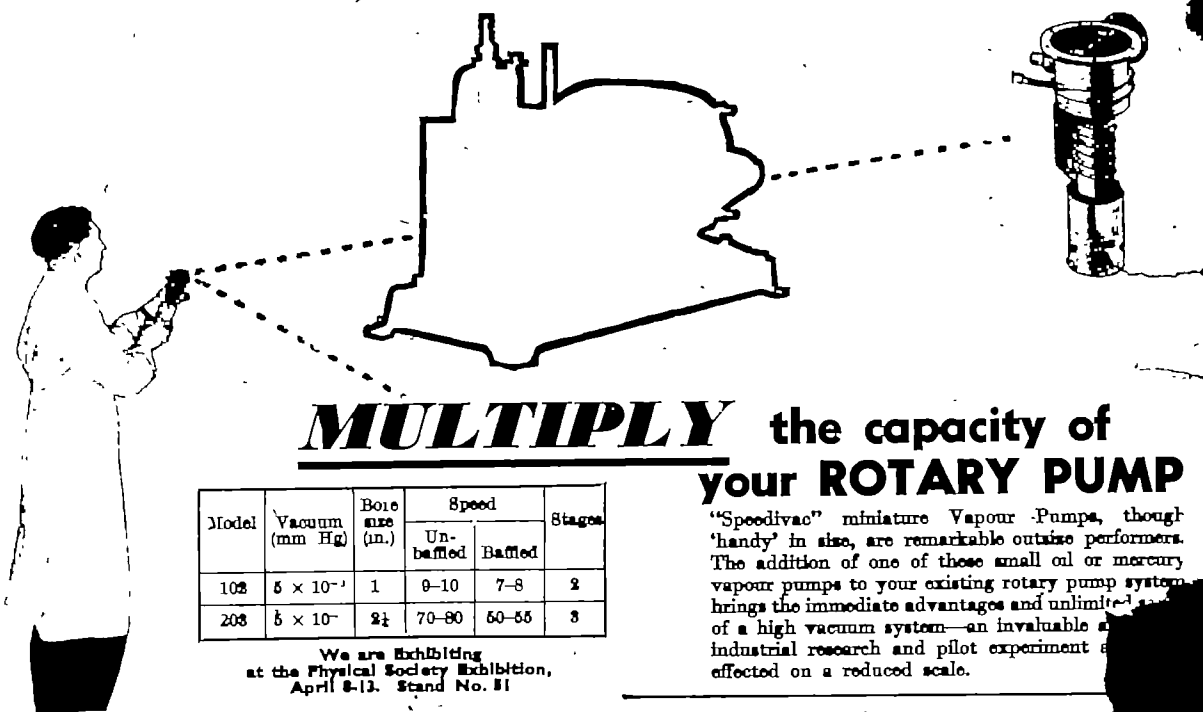
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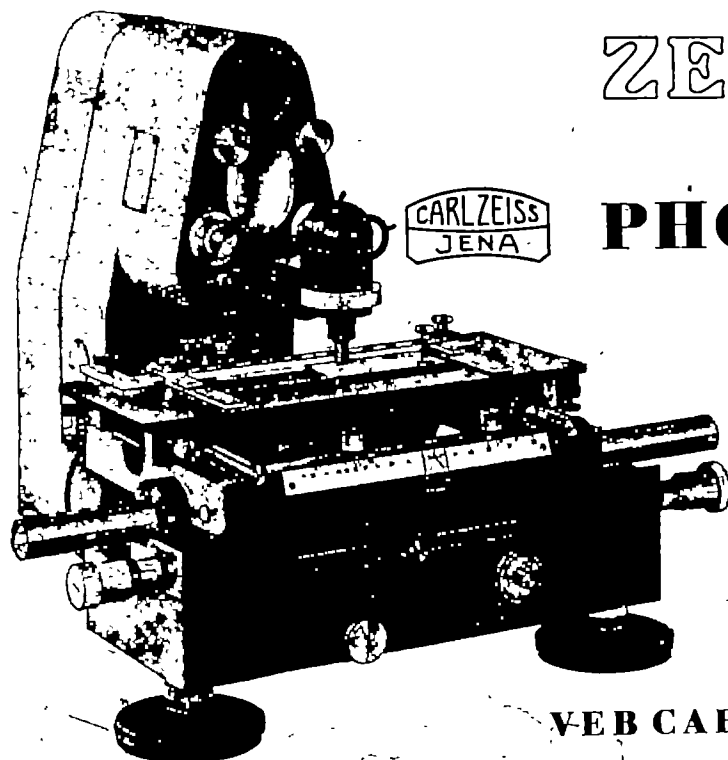
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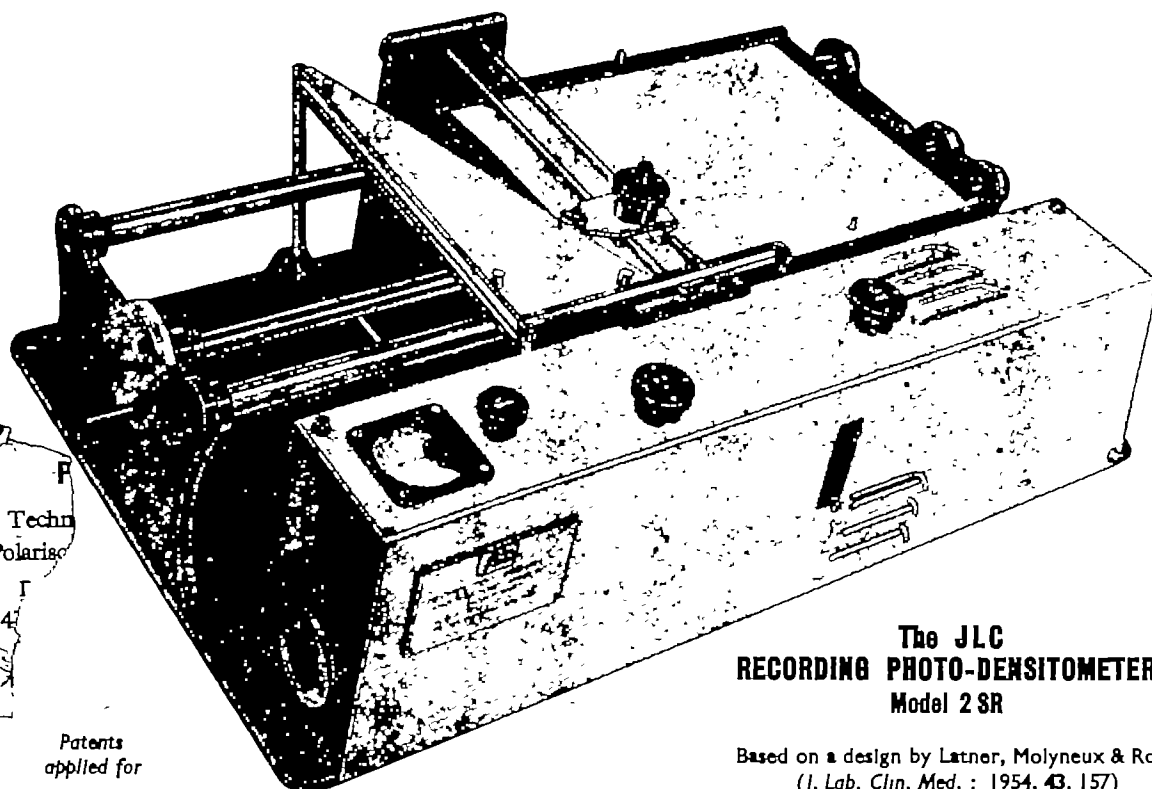
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NATURE

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THE INDEPENDENT RESEARCH INSTITUTION

THE major and wider interest of Dr. Vannevar Bush's report for 1952-53 as president of the Carnegie Institution of Washington lies in his review of the position and opportunities of the privately endowed research institution to-day, particularly in view of the concern so freely expressed in the United States and elsewhere as to the growing dependence of fundamental research on government support. Dr. Bush begins his report with an appreciation of the particular opportunities of the Carnegie Institution itself, before turning to discuss the position of the independent research institution in general. His observations are an important contribution to a discussion which was provoked afresh by the analysis of government expenditure on research in the United States carried out by the National Science Foundation, and they have a close bearing on the future activities of such bodies in Great Britain as the Nuffield Foundation and the Carnegie United Kingdom Trust.

Dr. Bush is impressed by the opportunities which confront the Carnegie Institution, provided national conditions permit it to operate effectively. He sees the Institution's work on the genetics of lower organisms and the earlier phases of life processes as fundamental to the future use by man of lower organisms for food production, to separation of raw materials from the sea and the synthesis of complex organic compounds for industry or for physical welfare: "There is evident opportunity for another fifty years of exacting endeavour in elaborating a constantly widening set of concepts". So, too, he believes that out of the Institution's studies of the ionosphere, of terrestrial magnetism and of geophysics, may come improved communications, new sources of materials and a fuller understanding of man and his environment.

Turning to the general position, Dr. Bush points out that the view that the day of the independent research institution is ended and that in future fundamental research belongs to the universities with heavy subsidies from government implies two criticisms. First, it implies that the research institution is isolated and that the interchange and cross-fertilization of a university community is essential now that disciplines are becoming more intimately interlinked. Second, it implies that fundamental research and the education of brilliant students should be closely related, and that the research institution is prone to ingrowth and stagnation in the absence of the continued impact of young minds. Dr. Bush admits that these are cogent points of which the research institution must take account. He does not admit, however, that the criticism is necessarily valid. These are dangers to be watched rather than reasons for abandoning the research institution. Isolation is a matter of attitude rather than of geography, and it can characterize a university department as well as an independent institution. A research department far from universities may

become a national or even a world intellectual centre in its field, where those intimate interchanges between masters occur which are often the seeds of progress. Dr. Bush's remarks bear pertinently on the question of academic interchange and the wisdom of doing all that is possible to foster schemes for academic interchange now being operated.

Nor is formal education, which is not the business of the research institution, the only means of contact with youth. Dr. Bush maintains that if a research institution allows itself to become old in its ways the fault is its own, and especially, he suggests, in its methods of selecting and treating its staff. If it is careful to expose itself constantly to the influence of young minds, to select its recruits not simply for their mental ability but also for their capacity to blend into a scientific community, and if its younger members are at once given the opportunity of participating effectively in its programmes, its group discussions and plans, the research institution will go far towards maintaining its vigour and avoiding the danger of rigidity and narrowness to which a community of scientists alone is liable.

This problem is inherent in all research organizations, and Dr. Bush is emphasizing much that was well put in the Barlow report on scientific staff ten years ago. His essential point is that the research institution is quite as well able to create the conditions which will attract outstanding men and give full play to their creative ability as any other form of research organization; and apart from this, he believes that the independent institution has advantages which more than offset any dangers of rigidity or ossification. Outstanding achievement in fundamental research is above all a matter of locating the individual of genius and supporting him liberally as he pursues his own way. Dr. Bush's philosophy is fully in line with that expounded by Mr. Raymond B. Foedick on behalf of the Rockefeller Foundation and Mr. Chester I. Barnard for the National Science Foundation.

It is, however, not to the utterly lone genius, incapable of working with others, that scientific advance owes everything; we must also consider those whose brilliant creative skill is combined with the human attributes that make them welcome in a community of their peers, so that their full creative contribution is seen not merely in their own direct results but also in terms of men as well. Dr. Bush believes that the independent research institution, free from the distractions of teaching, is even better placed than a university department to provide the climate in which such individuals can function to the best of advantage. He believes also that the research institution, with its tightly knit groups, is also better equipped than the university department for locating genius before it has matured and established a reputation. Young men of promise are best picked by men in the same field, subject to checks first by senior colleagues, and then, as in the Carnegie Institution of Washington, by such officers as the president and trustees, who are concerned to see that high standards are maintained and due diligence emphasized in the quest for talent.

A new young scientist of great creative ability is best developed, in Dr. Bush's opinion, by incorporation in a group consisting largely of men of that character, whose selection of novices, rotation and further selection is under the leadership of a scientist possessing the sound judgment in the selection of men which is a primary attribute of a successful director of research.

All this can, of course, be done in a university department, though so far as fundamental research is concerned, Dr. Bush thinks, less successfully. These are his reasons for believing that, provided the research institution is adequately endowed, fundamental research can be carried on more fruitfully in it than anywhere else; and on this question of endowment Dr. Bush is highly critical of recent trends in the finance of research in the United States. He points out that the sponsoring of fundamental research by the Government has not hitherto increased significantly the volume of fundamental research. More important, it has not, by sponsoring, created new centres of research or secured the permanent expansion of existing centres. Moreover, the great foundations have turned away from endowment grants and distributed their funds mainly on a project basis.

Although this distribution, as is clear from such reports as those of the Rockefeller Foundation and the Nuffield Foundation, has been directed largely towards what are, in the judgment of their trustees, the growing points, in accordance with the view for which Lord Beveridge argued so cogently in his report on "Voluntary Action", Dr. Bush believes that, by keeping the selection of actual projects in their own hands, the Foundations have hindered the full expansion of fundamental research. He believes they have missed an opportunity. When the Government began to increase strongly its support of scientific research, they should have maintained the balance by increasing their own support of fundamental research, and particularly by creating and endowing new independent institutions where it was most likely to prosper.

Dr. Bush admits that something has been done; but he maintains nevertheless that the scope for fundamental research has expanded far more than the means for its furtherance. In general, independent foundations have not tackled the problem of extending fundamental scientific research in the United States, nor is there any great indication that they will do so.

So far as the United States are concerned, Dr. Bush's remarks have to be considered in the light of the opinion freely expressed in that country that the level of fundamental research is far below what is required to enable it to make contributions to the advancement of science, as distinct from technology, commensurate with its greater resources. The National Science Foundation's recent inquiry showed that in 1951-52 the total funds available to non-profit institutions for research and development were 338 million dollars, compared with the Federal Government's appropriation of 2,217 million dollars; and although the latter figure is estimated at 2,074 million dollars for the fiscal year 1953-54, the

resources of non-profit institutions are unlikely to exceed the previous 15 per cent of the Federal funds available for research and development. Moreover, from the latter funds expenditure on fundamental research is of the order of 120 million dollars, or some six per cent of the total, and this expenditure tends to increase less proportionately than that on applied research and development. Further, of the funds going to non-profit institutions, only about 20 per cent was for basic research, the remainder being for applied research and development. Even in medical research there has been a similar trend, Federal funds providing a major source of support—roughly 76 million dollars out of 181 million dollars in 1951, compared with 60 million dollars from industry. The Commission on Financing Higher Education in the United States estimates that out of 222 million dollars expended by higher education institutions on organized research in 1950, about 60 per cent was on contract research for the Federal Government.

American opinion is thus disturbed, both that this large Federal contribution is not big enough for the amount of fundamental research that is desirable, and that it represents too high a proportion of the funds available for the research institutions. This latter concern is increased because, as the Commission on Financing Higher Education in the United States suggests, much of the Federal support goes for purposes ill-related to those which the research institution is primarily concerned to further. Apart from the danger of distortion inherent in this position, concern has been expressed, for example, by Mr. R. D. Reid, of the Office of Naval Research, that the effects on individual freedom and initiative may be adverse. Although the Office of Naval Research seeks to administer its research programmes and funds so as to stimulate creative work and the increase of fundamental knowledge, Mr. Reid views the trend towards Federal support with uneasiness. He distrusts reliance for funds upon any single agency, even the National Science Foundation, for support of basic research even in the medical sciences. Finance is not the sole or even the most important requirement, and several agencies, with their differing points of view, their various needs and different groups of advisers, offer a greater safeguard against uniformity, and assurance that due consideration will be given to research projects in entirely new fields—to the potential growing points—of which bodies such as the Rockefeller and Nuffield Foundations and the Carnegie Institution are rightly mindful.

The Office of Naval Research carries responsibilities which in Great Britain largely fall on the Department of Scientific and Industrial Research or the Medical Research Council, and this warning as to the limitations of administration deserves to be noted. Moreover, while accepting the necessity of group research or team-work, Mr. Reid reminds us that the important discoveries are usually the result of the intellectual adventures of talented individuals, and his comment that in his personal experience some enforced frugality has stimulated productivity is parallel to an observation of Sir Ernest Barker in his recent book. Sir

Ernest wonders whether we do not think too much about equipment and accommodation. They matter, but perhaps not as much as we think. Sir Ernest's experience that poor accommodation is often a spur to good education is, of course, not a justification for ill-equipped laboratories, but endorsement of the truth of Rutherford's remark: "We haven't any money; we've got to think".

Still more recently, President H. W. Dodds, of Princeton University, has discussed the dangers and limitations of project research in a statement on university research policy published in the *American Scientist* (42, 128; 1954). President Dodds recognizes that the team-work usually demanded in sponsored research when it is good can make for cross-fertilization and mental stimulation, while the external discipline laid upon the leader and his team to see that the trust is honoured is also an advantage. None the less, there is a danger of diminishing returns, and like Mr. Reid, Dr. Dodds notes the danger of decreasing self-reliance and of over-planning and regimentation. A university, he insists, must never, in accepting projects, swerve from its obligation to advance fundamental knowledge, but above all Dr. Dodds is concerned that the imposition of secrecy in connexion with sponsored projects contravenes the prompt and free pooling of knowledge by which all science advances.

Any barrier to the free trade in ideas throttles the process of discovery, and Dr. Dodds suggests that three principles should determine the acceptance of any sponsored research project by a university. The sponsored undertaking should be related to the fundamental long-range programmes of the faculty concerned. Second, the undertaking must not interfere with the university's duty to maintain and improve its own resources and facilities for the support of its own programmes; and third, the university must exercise the same diligence and wisdom in the utilization of its own resources as it does in respect of grants which it accepts from outside for sponsored research.

Apart, however, from the dangers which may beset the research institution if it does not exercise great discrimination in the acceptance of sponsored projects, there is a further difficulty, to which Dr. C. P. Richter has directed attention in an article, "Free Research versus Design Research" (*Science*, 112, 91; 1953). Dr. Bush in his report to the trustees of the Carnegie Institution recognizes the importance of the Institution retaining the power to select its own projects in the light of the collective wisdom of the research group. Mr. Richter hammers home the point that unless the individual has reasonable freedom, we do not get the best out of him. Funds for research, he argues convincingly, should be given with as few strings attached as possible. Experimental design should not be mistaken for ideas, and it is the man rather than the project who should be backed, at least so far as fundamental research is concerned. These points are just as applicable in Great Britain as in the United States, and those concerned with the allocation of funds for research should always have them in mind.

ATOMIC ENERGY IN GREAT BRITAIN AND THE UNITED STATES

Britain's Atomic Factories

The Story of Atomic Energy Production in Britain. By K. E. B. Jay. Pp. ix+100+16 plates. (London: H.M. Stationery Office, 1954.) 5s. net.

Report on the Atom

What You Should Know About Atomic Energy. By Gordon Dean. Pp. 288+16 plates. (London: Eyre and Spottiswoode (Publishers), Ltd., 1954.) 16s. net.

THE nearly simultaneous appearance of these two books on the subject of atomic energy is in a sense a real landmark in the history of the subject. Both are written with inside knowledge of the spectacular developments made in recent years in this rapidly growing field. One is concerned with British progress and the other with American. The report by Mr. K. E. B. Jay is more restricted in its scope and, indeed, he does not stray far from the chosen subject of factories at any time. On the other hand, Mr. Gordon Dean gives his attention to nearly all the questions that are involved in any comprehensive study of the atomic energy programme, including the use of weapons. Yet the aims of the authors are very similar. Throughout they are anxious to explain the methods of the responsible bodies, the Ministry of Supply in Britain and the United States Atomic Energy Commission, and they perform their tasks with clarity and as much detail as necessary.

Both writers achieve an unusually high standard of lucidity in expounding what is largely a complicated scientific and technological subject. There is some little suggestion of the expert turned reporter in Mr. Jay's work and what one might call the reverse in Mr. Dean's. But the degree of success is such as to leave one with a feeling of regret that such instances do not occur more frequently. It is obvious that a law training is not lost in scientific fields.

The bulk of each book is concerned with a highly complex scientific and engineering project, and in spite of their notable success it is still true to say that the educated layman will find much that is difficult to digest. All the material is interesting and even stimulating to the careful reader; but the books are meant for serious study, and application is essential to extract anything like their full value. Mr. Jay's account shows clearly a desire to provide the scientific basis for the various processes described, but he is wise in providing the exposition of the underlying physical principles in the form of an appendix. This allows him to proceed without seriously overloading the average reader at any point. Mr. Dean succeeds very admirably in this same respect by virtue of his ready ability to draw neat analogies from more familiar fields of experience.

The specialist will find a great deal to interest him in these books. The comprehensive sweep of the authors over fields involving physics, chemistry and engineering serves to clarify the principal trends in the whole project. In spite of unprecedentedly firm control of publication, there has been a great number of papers from the various laboratories involved, and these books help in relating many of these specialized publications. Both books start with prospecting for ore and go as far as the pile for energy production

or the door of the weapons factory. Mr. Dean side-steps actual weapon production; but he has many interesting and timely points to discuss concerning tests, stockpiling, strategy and other related topics. Regarding tests, many scientists will envy electricians who can earn 800 dollars a week, even if the circumstances are exceptional. In addition to handling weapons, Mr. Dean considers security and the Russian effort; here he shows a reasonable middle-of-the-road approach which will be favoured by many and which can provoke very few.

In one respect both writers, through no fault of their own, leave the reviewer rather unhappy. Much of their effort is expended in demonstrating how well both programmes have been handled. This appears to be a rather barren effort as there are no standards of comparison, or very few, in this field. Both are national efforts, and security prohibits any estimate of the cost of an atom bomb or even an ounce of plutonium, say. It is somewhat like the situation when the management insists that it has cleverly handled affairs, but nevertheless refuses to give any financial statement on the operation. It is difficult for the shareholders to join the eulogy no matter how sympathetic they feel towards the claims of the personnel. Apart from this question of what might be termed efficiency, there is left with the reader a very real sense of difficulty in estimating how long it will be before piles supply useful energy on a commercial basis.

There is a compactness and neatness in the British programme as described which contrasts rather strongly with the apparently more haphazard and empirical approach in the United States. Yet somehow one is impressed with the feeling that the latter method would probably achieve real results very quickly if it was directed mainly along the line of peaceful applications. The main contrast, indeed, in the two countries is not in technological matters, although differences do appear here (as, for example, in the processing of ores), but rather in its organization. The American scheme of awarding contracts to industrial companies, mostly of major standing, on a cost plus nominal fee basis does not have a real counterpart in Britain. Although many well-based objections can be made to the American system, and these are fully and frankly voiced by Mr. Dean, one is yet aware of the enormous benefits that can accrue when it proves successful. One feels that the more tightly governed British effort could result in a severe handicapping of the major firms in the international race towards successful tackling of the many original scientific and technological problems created in the widespread application of atomic energy in a peace-time economy. Names such as Du Pont, General Electric, Westinghouse and Union Carbide and Carbon appear throughout the American report, and in several instances the whole problem is left to these concerns. The difficulty of ensuring that full use is made of the nation's skill is aggravated by the fact that the British effort was delayed by the transfer of the whole of the British personnel to the United States during the War. Thus the American manufacturer had a big start in the new field, and his progress in the construction of ship reactors (submarine) is perhaps an especially noteworthy example of this.

The above is merely one of the many issues that will occur to the thoughtful reader of these two authoritative and excellent accounts of the work in atomic energy. All non-specialists are indebted to

each of the writers for bringing under one cover so much of a subject which is of vital concern to all. Both books can be very highly recommended. They are in no sense in competition with each other—they are, in fact, complementary. They are excellently produced and cheap for books of their type. It is unfortunate that Mr. Jay's work is not produced with a more durable cover. S. C. CURBAN

PHILOSOPHICAL ANALYSIS OF 'OBJECTIVE' PROBABILITY IN SCIENCE

Scientific Explanation

A Study of the Function of Theory, Probability and Law in Science. By Richard Bevan Braithwaite. (Based upon the Tarnier Lectures, 1946.) Pp. xii + 376. (Cambridge: At the University Press, 1953.) 40s. net.

THE eleven chapters of this book are intended to examine (or re-examine ?) the logical features of all sciences. The term 'science' is understood to mean a hierarchical deductive system in which the lowest-level generalizations from the observed facts are deduced from more-general higher-level hypotheses. This very general level of discussion is maintained in Chapters 1-4 (introduction; scientific deductive systems and their representations; the status of theoretical terms in science; models for scientific theories, their use and misuse). Also, the same general tone is characteristic of the last four chapters (the justification of induction; laws of Nature and causality; causal and teleological explanation; explanation of scientific laws). The middle of the book, composed of three chapters (statistical hypotheses, probability statements and class-ratio arithmetic; the meaning of probability statements within a scientific system; the choice between statistical hypotheses), is much more specific than the rest and deals with the gnoseological questions related to modern theories of probability and statistics and, more particularly, to the applications of these disciplines in experimental sciences.

In his preface Mr. R. B. Braithwaite states that, "if I were asked what there is that is original in this book, I should mention specifically the accounts of probability as used within a science (Chapters V and VI) of the relation between scientific theories and 'models' of them (Chapter IV), and of teleological explanation (Chapter X)". With respect to the other parts of the book, the originality of the author is limited to exposition. No doubt, because of my personal inclination, the most interesting parts of the book appear to be Chapters 5-7, which are given to probability and statistics. Since the appearance of J. M. Keynes's "Treatise on Probability" (1921) and through the writings of Sir Harold Jeffreys, the philosophical literature on probability has mostly been based on the view that the term probability reflects in some way the intensity of belief of an individual in a given proposition. For this reason, the particular theories are sometimes called 'subjective' theories of probability. On the other hand, beginning roughly with the last years of the nineteenth century (Karl Pearson), a tremendous amount of work has been done on the development of the mathematical machinery and on its applications to the various branches of empirical science

in which an essential part is played by relative frequency. This 'relative frequency' is attached to the appearance of various 'events' in repeated 'trials' either going on by themselves or performed by man. The idealized relative frequency became labelled with the same term 'probability'. Since the assertion that probability (understood as an idealized relative frequency) of a given event has a specified value p may be verified experimentally, the relevant theory is sometimes called the 'objective' theory of probability.

Perhaps because of the enormous field of applications (physics, astronomy, biology in general and heredity in particular, social sciences and experimentation) that kept the scholars busy with immediate specific problems, the existing philosophical literature concerned with 'objective' probability appears to be much less rich than that dealing with the 'subjective' probability. The honour of initiating the philosophical study of objective probability seems to belong to R. von Mises ("Wahrscheinlichkeit, Statistik und Wahrheit", Vienna, 1928). To my knowledge, the present book represents the next (after von Mises) serious effort to analyse the position and the meaning of objective probability in the body of modern science.

While the author's attitude towards probability in science seems to coincide with that of von Mises, there are very considerable differences in the developments. First, Mr. Braithwaite refuses to adopt von Mises's definition of probability as the limit of relative frequency. The definition adopted, based on the so-called 'class ratios', is essentially the same as the now classical definition of Kolmogoroff. (Here, however, somewhat to my surprise, the author is reluctant to deal with infinite sets and measure.) Furthermore, at the time when von Mises wrote his book the basic concepts of the modern statistical theory were much less clear than they are now, and this is reflected in von Mises's writings. Mr. Braithwaite has benefited from his proximity to the Cambridge Statistical Laboratory and, with the acknowledged co-operation of F. J. Anscombe, has mastered the young mathematical discipline. As a result, his book appears to contain the first presentation of the principles of mathematical statistics intended for a non-technical reader. This presentation is concise and at the same time quite inclusive, from the theory of testing statistical hypotheses, through estimation, to the general theory of statistical decision functions. Also, and this is quite an achievement, Mr. Braithwaite's presentation of the theory is devoid of the various misty mysticisms so frequently encountered in the many not quite technical books written by statisticians. In fact, they (the statisticians) will do well to read Mr. Braithwaite's book. Some of them will probably disagree with him on a number of points, but the process of disagreeing will be instructive. In general, the book is likely to be interesting to everyone anxious to attain a unified outlook on science.

One bibliographical remark seems in order. The concept of loss function, $L(h_1, h_2)$, that represents the financial loss to the statistician who accepts the hypothesis h_1 when, in fact, an alternative hypothesis h_2 happens to be true, is frequently attributed to Wald. There is some justification for this because in modern times Wald was the first to make extensive use of this concept, combining it with the 'minimax' idea. However, it is interesting that the loss function appears in the writings of Laplace in the form of

'detriment' that one will suffer when using an estimate $\hat{\theta}$ of a parameter the true value of which is θ . Laplace chose a particular form of the function to represent the 'detriment', namely, $|\hat{\theta} - \theta|$. Later on, the same problem was considered by Gauss, who noticed that much simplicity is gained by assuming the alternative form of the detriment $L(\hat{\theta}, \theta) = (\hat{\theta} - \theta)^2$. Incidentally, the adoption of this form of loss function initiated the theory of least squares and caused the contemporary preoccupation with the mean square error of an estimate, which is exactly the expectation of the detriment. In more modern times, the concept of the loss function or of detriment appears frequently in the writings of F. J. Edgeworth, but then, for some reason, became entirely forgotten. In 1933 the concept was rediscovered by E. S. Pearson and myself (*Proc. Camb. Phil. Soc.*, 29; 1933), and combined with the notion of what is now known as the minimax policy. However, after formulating the idea, we did nothing with it. The next rediscovery of the idea was due to Wald, who used it to the fullest extent and on it built his remarkable general theory of statistical decision functions. JERRY NEYMAN

HIGH-SPEED FLUID FLOW

Modern Developments In Fluid Dynamics

High Speed Flow. Composed under the aegis of the Fluid Motion Sub-Committee of the Aeronautical Research Council. Edited by L. Howarth, with the assistance of H. B. Squire and the late C. N. H. Lock. (The Oxford Engineering Science Series.) Vol. 1: pp. xvi+476+9 plates. Vol. 2: pp. viii+400+17 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 84s. net the set.

THE publication of these two volumes on aerodynamic phenomena as affected by the compressibility of the air will satisfy a long-felt want by many workers in the aeronautical field. Like their predecessors, these volumes appear under the aegis of the Fluid Motion Sub-Committee of the Aeronautical Research Council, but the editor is Prof. L. Howarth in place of Prof. S. Goldstein, to whom the work is dedicated.

The original volumes dealt only with the problems of fluid dynamics at speeds sufficiently low for the density of the fluid to be considered a constant. The very rapid progress of flight into transonic and supersonic regions has produced a great demand for aerodynamic data at such high speeds, where the effects of variations of density, viscosity and temperature can no longer be neglected and indeed play a dominant part in determining the nature of the flow. These two volumes set out to supply this need as far as is possible at the present time when many of the problems involved are far from completely solved. The editor and his collaborators are to be congratulated on the production of a fine work, especially as they must have felt themselves greatly hampered by the lack, in very many cases, of sufficiently extensive experimental data to enable them to assess the validity of approximations necessarily made in the theoretical treatment of the subject.

It can truly be said that in this field theory has outstripped experiment and that the great need of the moment is a systematic body of experimental

data such as has been amassed during the past thirty years or so for the case of low-speed flight. There are two reasons for this lack: in the first place, problems of high-speed flight have been under intensive consideration for a comparatively short time; and in the second place, the equipment needed for their adequate experimental study is much more elaborate and expensive than that which sufficed for low-speed problems.

Dealing first with the theoretical side, which is the special province of the first volume, the field of investigation divides itself roughly into two parts. There is first the range of speeds from that at which compressibility begins to matter to that of sound, and this range is particularly difficult from the theoretical point of view when the field of flow comprises both subsonic and supersonic velocities and is characterized by shock waves of limited extent springing from the surface of the body considered. Secondly, there is the true supersonic range in which velocities are everywhere supersonic, so that the mathematician is no longer confronted by equations of both elliptic and hyperbolic type in the same field of flow. There are not yet, in fact, any complete analytical solutions of flow problems in which limited shock waves exist, but only in the cases where the speed is below that at which shock waves form or above that at which the flow is completely supersonic. Nevertheless, it is possible to throw some light on the intervening region by approximate methods.

After a general introduction and description of high-speed flow, the equations of flow in gases are elaborated, and in succeeding chapters the implications of these laws of flow are traced. The method of characteristics is described, and the properties of shock and blast waves examined. The hodograph method is treated at some length, and there is an interesting chapter on approximate methods, some of which have been of great use, despite their limitations, in giving the aeronautical engineer a basis for supersonic design. Problems of unsteady flow are next considered and complete the review of theoretical methods as applied to flow in an inviscid fluid. The last chapter, on boundary layers, shows how the methods previously developed for incompressible flow have been extended to the compressible case, and also contains some account of the interaction of shock waves and boundary layers, a subject as yet far from being completely understood.

The second volume, apart from its last chapter, deals mainly with the experimental study of high-speed flow. An account is given of the apparatus and methods that have been devised for such research, including force measurements, determination of pressure distribution, and visualization of flow by shadowgraph, schlieren and interferometer methods. Two chapters follow in which some of the available results are given on aerofoils and cylinders, and on bodies of revolution, illustrated by numerous diagrams and some excellent flow photographs. The discussion on bodies of revolution is confined mainly to spin-stabilized projectiles, and it is pointed out, quite rightly, that the study of projectiles took workers into the supersonic field even before flight was regarded as a serious possibility. It is an interesting thought that two apparently widely separated investigations, external ballistics and the aerodynamics of flight, have now merged together, and each can help the other in no small measure. The last chapter of the second volume deals with the

problem of heat transfer at high speeds. This is a matter of very great importance, and one that will become even more important as flight speeds increase, for it seems likely that the ultimate speed of man-carrying aircraft will be set by the thermal problems involved. Theoretical methods of dealing with heat transfer are considered, and their predictions, compared with experimental results, indicate that knowledge is in a fairly satisfactory state, considering the complexity of the problem.

The present volumes, like their predecessors, are provided with very copious references to other work on the subjects discussed. Recent progress in the theoretical and experimental study of high-speed fluid dynamics has been very extensive indeed, because of its obvious and vital importance in the development of air defence, and it is quite impossible to treat more than the broad outlines of the subject even in two fairly large volumes. The reader who wishes to look more closely into any particular part of the subject will find the references of great value.

While much of the theoretical matter is fundamental and will stand permanently, there seems little doubt that the present intensive experimental programme, in Britain and elsewhere, will very soon enable the subject to be treated far more fully. For the moment, the present volumes form probably the most complete account of the subject yet published.

ERNEST F. RILEY

MASS SPECTROMETRY

Modern Mass Spectrometry

By Dr. G. P. Barnard. (Physics in Industry Series.) Pp. 326. (London: Institute of Physics, 1953.) 50s.

MANY still think of the mass spectrometer as a highly academic instrument, details of which have to be remembered only long enough to pass examinations in physics, whereas, as Dr. G. P. Barnard's book shows, it is now a powerful tool which has successfully invaded the world of industrial and biological research. The last five chapters of the book are, in fact, devoted to a discussion of some of the problems tackled by mass spectrometers. The longest of these chapters concerns only one application—the analysis of hydrocarbon mixtures; and here the actual position is well reflected, for it is in the oil-refining industry that mass spectrometers are now most used. The following chapter is devoted to applications in chemistry; and another is concerned with the use of mass spectrometers in biology. The latter contains also much useful material of a general nature on the techniques peculiar to stable-isotope tracer work with deuterium, carbon-13, nitrogen-15 and oxygen-18 respectively. Other shorter chapters are concerned with geology, physics, nuclear chemistry and engineering.

It should not be thought, however, that the mass spectrometer is not itself discussed in detail, for more than half the book is devoted to its general theory and design. Dr. Barnard's work on gaseous ion sources and their errors is well known, and his chapter on ion sources should therefore be approached with some respect. The space allotted to sources suitable for solid samples, however, is small; largely, of course, because little work has been published about them. This is regrettable, for in spite of their in-

conveniences and inefficiency the use of a source of this type could often, one feels, short-circuit a routine chemical operation involving small quantities of gas—always a laborious affair.

It is in those sections of the book dealing with more fundamental matters that a few obscurities appear. Thus, in the section dealing with circular motion of a charged particle in a uniform magnetic field, we find the statement "there is no linear acceleration but a constant angular acceleration". Again, electrostatic units are used here, but later, without warning, a formula appears which is based on Gaussian units; and on p. 73 we read of the "normal to a point". Such minor matters, however, are few in number and do not detract appreciably from the value of the book as a whole.

One cannot conclude a review of this book without mentioning the very full list of references, containing nearly five hundred entries—a most useful appendix. For its size, the book is expensive; this is doubtless because the publishers cannot expect to sell it in really large numbers, for its material is somewhat specialized. Yet for this very reason the Institute of Physics and the author are to be congratulated on their enterprise, for the book will be of great utility to many research workers in helping them to appreciate the possibilities—and limitations—of mass spectrometers.

D. F. BRACHER

"STRASBURGER'S TEXT-BOOK"

Lehrbuch der Botanik für Hochschulen

Begründet von E. Strasburger, F. Noll, H. Schenck und A. F. W. Schimper. 26. Neu bearbeitete Auflage. Bearbeitet von Prof. Hans Fitting, Prof. Walter Schmumacher, Prof. Richard Harder und Prof. Frantz Firbas. Pp. xii+661. (Stuttgart: Gustav Fischer Verlag, 1954.) 28 D. marks.

A FUTURE historian of botanical literature, surveying both sides of the Atlantic, may well regard the present period as the heyday of text-books, certainly of those that aim at instruction at the 'intermediate' level; the reflective, contemporary teacher may easily find himself wondering how long the large (and expensive) text-book will continue to hold its own in schools and universities. The volume being considered here is, of course, the one that has been long and widely known in its English translation as "Strasburger's Text-book". In parenthesis, we may perhaps note that the sixth and last English edition, translated by Prof. W. H. Lang and published by Messrs. Macmillan in 1930, was based on the seventeenth German edition. Now, in this, the twenty-sixth German edition, we may say that not only does the soul go marching on, but also the body, at least in its general framework, has remained relatively unchanged, although it has been appropriately brought up to date within the limitations of that framework. On the title-page acknowledgment is still made to its original authors of 1884—Strasburger and his colleagues—and in the prefatorial matter the comprehensive authorship of the several sections during the past seventy years is set out.

As in the earlier editions, the book begins with morphology, which is subdivided into cytology, histology and organography, with a short section dealing with the theory of descent and the origin of adaptations. In the second section, physiology is considered under metabolism, development (actually

changes of form) and movement, genetics and the effect of environmental factors being considered as subsections of the physiology of development. The third section, which deals with the systematic arrangement of plants from Schizophyta to Monocotyledonae, retains the general form of earlier editions, though within some subdivisions and classes there has been extensive rearrangement. Some of these new taxonomic arrangements differ considerably from those in earlier editions and also from those in what may be described as recent standard works. The Algae afford one example of this, the retention of the concept of Pteridophyta another. As the materials in this section are necessarily very condensed, and as we have by no means come to a stage of finality in the resolution of the problems of taxonomy, it would be quite impossible in a short review to enter into detail on this aspect. The most evident single new addition to the original publication is the inclusion, since the twentieth edition, of a section on plant geography.

The reviewer of a broad conspectus of the subject such as this naturally tends to test it by scrutinizing in detail those sections with which he himself is most familiar. On the basis of this criterion it can be said that this new edition has been comprehensively modernized—review literature as recent as 1952 is cited in some of the sections—and that the student can gain access to representative recent and contemporary data and ideas, if not in the unavoidably condensed text, then from the judicious selection of literature cited at the end of the book. We have, in short, the qualities and limitations of the old substantial "Strasburger", with some of its coloured illustrations still retained, and still affording a comprehensive and representative survey of scientific botany in its many branches. O. W. WARDLAW

PROGRESS IN PHYSIOLOGY, 1952-53

Annual Review of Physiology

Victor E. Hall (Editor), Jefferson M. Crismon and Arthur C. Giese (Associated Editors). Vol. 14, 1952; pp. x+589. Vol. 15, 1953; pp. x+558. (Stanford, Calif.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1952-53.) 6 dollars each vol.

EVERYONE with any interest in physiology must be deeply grateful to those who produce the "Annual Review". The lists of contents of the volumes for 1952 and 1953 promise good reading, with an attractive mixture of young men and famous names. The editorial policy in choosing fields, the balance kept between basic physico-chemical aspects and the physiology of highly organized systems are admirable. The guidance to those preparing review articles for these volumes and the hope that the reviews will reflect the personal views of the author are obviously enlightened; and yet there is scarcely more than one article in each volume which one reads with pleasure as well as profit.

There are a few minor blemishes. It should be easy to remove more of the errors in English grammar of the European contributors, and one could wish that time permitted the correction of comments which seem to be unintentionally ambiguous. The real difficulty lies in the degree of responsibility which any one author feels able to accept for passing over

nonsense in silence, praising discriminatingly, criticizing even widely accepted views, and on occasion proposing some new framework to carry the facts available.

Selection of papers to be mentioned cannot be easy. One author plaintively remarks that three thousand articles on the thyroid have appeared during the past two years. While the "Quarterly Cumulative Index" and the newcomer, the "Current List of Medical Literature of the U.S. Armed Forces Medical Library", are available, there is no need for "Annual Review" to catalogue. I feel that even more vigorous selection of titles is unlikely to leave many gems in obscurity, and that reviews with more than two hundred references are overlaid and indigestible. Other evasions of duty include the habit of saying that "the results of this author are not consistent with current concepts". Surely this is simply sitting on the fence. To say that *A* says white but 'in contrast' *B* says black, usually means that the reviewer has not bothered to see if *A* and *B* are working in comparable conditions.

Here and there reviewers can be heard grinding their private axes; but with such a glorious opportunity the temptation must be difficult to resist. One practice which should be sternly suppressed by the editor is Prof. J. F. Fulton's habit of publishing extracts from letters from authors on their unpublished experimental results. Clearly the reviewer has little chance of judging for himself the significance of work reported in letters, and he is poaching on the preserves of the reviewer for 1955. Fulton includes an attack on cybernetics on the grounds that it offers nothing conceptually new and has spread unhappy confusion among students. I feel that cerebellar tremor should be considered from the point of view of stable and unstable feedback mechanisms, instead of being ascribed, as it is now, to irregularities of muscle action. The present view seems both unhappy and confused.

Two most enjoyable papers were those of Alan Burton on "Peripheral Circulation" in the 1953 volume and J. R. Robinson and R. A. McCance on "Water Metabolism" in the 1952 volume. As a former physicist and for the past twenty years a biophysicist, Burton is well placed to castigate pretentious nonsense in physical aspects of physiology. His comments on "pulmonary capillary pressure", on the calculation of the area of stenosed mitral valve and on "coupled elastic rams" are well deserved. It is not surprising that while dealing such swinging blows he is occasionally unkind and even unfair. More of such vigorous criticism would have a salutary effect on authors.

The paper by Robinson and McCance is chiefly memorable for an expansion of ideas put forward previously by Robinson. They state the current view that all cells are in osmotic equilibrium with their environment, together with the experimental discrepancies, and decide that the current theory is not worth preserving. The alternative, that active transport of water is occurring across the walls of most cells and that their apparent equilibrium is in fact a dynamic steady-state, seems to provide a better starting-point from which to appreciate the differences between tissues, and it makes it possible to begin the interpretation of whole ranges of data. Fortunately such changes in outlook occur rarely; but in its short history "Annual Review of Physiology" can boast of a few such papers to which we turn again and again. D. WHITTERIDGE

British Association for the Advancement of Science Mathematical Tables

Vol. 10: Bessel Functions, Part 2, Functions of Positive Integer Order. Prepared on behalf of the Committee for the Calculation of Mathematical Tables by W. G. Bickley, L. J. Comrie, D. H. Sadler, J. O. P. Miller and A. J. Thompson. (Published for the Royal Society.) Pp. xi+255. (Cambridge: At the University Press, 1952.) 60s. net.

THIS volume, to quote the preface, is the last of the series of British Association Mathematical Tables and is thus both the fulfilment of a long-standing promise and the completion of a task. It forms a companion to Part 1 (Bessel functions of orders zero and unity), containing, as it does, tables of functions of integer orders from two to twenty, inclusive.

There is a comprehensive introduction of some forty pages consisting of page-index diagrams, an account of the preparation of the tables and the methods of interpolation used therein, together with a bibliography, a summary of notations and a most valuable list of the definitions of the functions and the relevant formulae.

The tables themselves are divided into eight distinct sections. The first gives $J_n(x)$ for the arguments 0-25 to eight decimal places, and the second a similar table for $Y_n(x)$. In the third and fourth, the functions $e^{-x}I_n(x)$ and $e^xK_n(x)$ appear to eight figures for arguments 0-20. Second differences are provided in all four cases, and the interval of tabulation is generally 0.1, but in smaller arguments sometimes 0.01. The last four sections deal respectively with $J_n(x)$, $Y_n(x)$, $I_n(x)$, $K_n(x)$, the entries here being to ten figures with a uniform interval of 0.1. The ranges of argument are as before, but this time no special provision is made for interpolation.

Meticulous care has been taken in the preparation and reproduction of this series of B.A. Tables by all concerned, and this particular volume conforms to the usual high standards.

J. H. PEARSON

Proteins and Enzymes

By Kaj Ulrik Linderström-Lang. (Lane Medical Lectures.) (Stanford University Publications: University Series, Medical Sciences, Vol. 6.) Pp. ix+115. (Stanford, Calif.: Stanford University Press; London: Cambridge University Press, 1952.) 24s. net.

NO laboratory has devoted itself so long to the fundamental problems of protein chemistry as the Carlsberg, and in these lectures Dr. K. U. Linderström-Lang has presented some of the topics pursued there during the past twenty years. If any short description is possible, it might be said that they truly reflect in the elegant simplicity of experiment and deduction the great tradition of Sørensen. The first two lectures describe the development and application of ultramicro methods in biology, a many-sided research to which Holter's name is inseparably linked. One feels here that artistry and science have shared equally in producing these beautiful methods, which have been applied to such varied material as moths, carnivorous plants, sea-urohin eggs, gastric mucosa, barley and *Chaos chaos*.

Two lectures are devoted to the initial action of proteolytic enzymes on proteins and the conversion of ovalbumin to plakalbumin. The latter has the greatest significance for interconversions which are much more important physiologically—the clotting mechanism and the activation of zymogens. This last topic is itself explored and discussed in relation

to the action of proteolytic enzymes themselves: whether they initially accelerate the opening out of the protein molecule. The methods used, changes of rotation and molecular volume, are characteristically simple.

The last topic deals with the biosynthesis of the peptide bond—not, as the title declares, the biological synthesis of proteins. This is a most useful and precise account. It is appropriate to add that, in contrast to the factual impersonality of much scientific writing, most readers will appreciate the familiar style, the clarity and individuality of the presentation.

KENNETH BAILEY

High Energy Nuclear Physics

Proceedings of the Third Annual Rochester Conference, December 18-20, 1952. Compiled and edited by H. P. Noyes, M. Camac, and W. D. Walker. Pp. iv+110. (New York and London: Interscience Publishers, Inc., 1953.) 2.00 dollars.

THIS record contains a résumé of the talks and discussions offered by the participants to the third annual Rochester conference on "High Energy Nuclear Physics", held during December 18-20, 1952. It is a very attractive record and one of the liveliest I have come across. This is due partly to the excellence of presentation and the topicality of the subject-matter offered. It reflects the spirit of informal discussion by reproducing the contributions in approximately verbatim form, often lightening controversial matters with speech and counter-speech.

The excellent summary by E. Wigner of the "Present Status of the Charge Independence and the Saturation of Nuclear Forces" opens the volume and is followed by contributions from various experts in the field. Next come the following: pion production and pion-nucleon scattering (under the chairmanship of E. Fermi); V^0 particles, generally only found in cosmic rays; and a session on the super-heavy mesons χ , κ and τ . Two chapters on theoretical field calculations and on experimental topics, respectively, complete the conference record. Of special interest to the experimental physicists in the last chapter are such exciting things as μ^- and π^- mesonic X-rays, and the decay of π^0 into positron and electron plus gamma-ray.

On the whole, one realizes the fact that our present knowledge of the properties of mesons and their interactions is very inaccurate and that it offers a wide field for the experimentalist who has access to big accelerators or is expert in cosmic-ray research. This conference report is essential for all research workers in this field and well worth reading by the general nuclear physicist. It costs only two dollars and is printed, fortunately, in big clear type.

E. BREITCHER

A Handbook of Colorimetric Chemical Analytical Methods for Industrial, Research and Clinical Laboratories developed for use with the Lovibond Comparator

Pp. 119. (Salisbury: The Tintometer, Ltd., 1953.) 15s.

THIS handbook consists of a collection of methods of colorimetric analysis using the Lovibond comparator with standard coloured-glass disks appropriate to each determination. In all, sixty different determinations are described, dealing with pH measurements, the analysis of organic and inorganic substances, and clinical determinations of such varied substances as *p*-aminosalicylic acid, blood phosphatase and lead. The introduction and general

description—adequately illustrated—describe the general method of carrying out colorimetric determinations.

The succeeding sections deal with individual determinations, preceded in each case with the relevant references to the scientific literature. The methods, which are clear and concise, have been drawn up in collaboration with laboratories engaged in each determination. As in all colorimetric methods, it is assumed that the preliminary preparation has eliminated interfering substances and that the colour quality given by the test is precisely the same as the disks, which are permanent. As pointed out in the introduction, "if the colour of the test solution is different from the glass standards, it is a sure indication that the reagents are stale or wrong, or the technique has not been followed correctly". The colour quality of the light used is important, as there may be considerable metamerism between the colour of the test liquid and the coloured disks. The operator is therefore directed to use a "uniform source of white light, preferably a north window".

While the modern tendency is for the use of a spectrophotometer or photoelectric colorimeter instead of visual methods, it must be admitted that well-standardized and authenticated colorimetric methods such as described have distinct advantages in simplicity and speed, and avoid certain difficulties associated with complicated instruments. J. KING

Yorkshire Birds

By Ralph Chislett. Pp. viii+335+10 plates. (London and Hull: A. Brown and Sons, Ltd., n.d.) 25s. net.

A NEW work on the birds of Yorkshire is very welcome, as many changes have taken place since Nelson and Eagle-Clarke's book was published in 1906. As is the case elsewhere, Yorkshire has suffered during the past quarter of a century from the increase of industrial development and intensive farming. The clearing of all deciduous woods and replanting with conifers has had a marked effect on the bird-life, and although the decline of game preservation and the breaking up of estates may have been good for birds of prey, it has led to a great increase in carrion crows, magpies and jays.

A chapter is devoted to these changes, and another gives a useful summary of bird migration in Yorkshire, both inland and on the coast. Spurn Point, at the mouth of the Humber, is an important point of arrival for migrants crossing the North Sea, and was formerly a great haunt of collectors. Now there is a trapping station where birds are caught and ringed, and much information is being collected on the movements of migrants on that part of the coast. The Brampton and Flamborough cliffs have long been famous as breeding places for vast numbers of sea-birds, including guillemots, razorbills and kittiwakes. Mr. Ralph Chislett writes that all is not well there: the kittiwakes have increased, but the numbers of guillemots and razorbills are much fewer than formerly, and this, he suggests, is owing to the over-collecting of their eggs and the mortality through oil pollution—a menace to which these birds are very susceptible. Certain species among the land-birds have also decreased; but, at the same time, others have increased. All this is well described in the author's interesting account of each species.

Mr. Chislett is to be congratulated on his volume, which will long remain the standard work on the birds of Yorkshire.

Volume and Integral

By Prof. Werner W. Rogoinski. (University Mathematical Texts.) Pp. ix+160. (Edinburgh and London: Oliver and Boyd, Ltd.; New York: Interscience Publishers, Inc., 1952.) 10s. 6d. net.

THIS small book provides an excellent introduction to the theory of the Lebesgue integral in n dimensions.

Part 1 is devoted to the problem of volume, the geometrical aspect of the integral being stressed throughout the book. First, sets of points are considered, and then the Peano-Jordan definition of content is discussed; this is followed by the Lebesgue definition of measure.

Part 2 first gives the theory of the Riemann integral of a function of n variables, defined geometrically (that is, in terms of 'volume'), using content as the underlying notion of volume. The Lebesgue integral is then dealt with in a similar way, on replacing content by measure. Finally, the theory of the indefinite integral of a function of one variable is discussed.

I agree with the author (see preface) that the elements of the theory of the Lebesgue integral should be included in a mathematical honours syllabus. This book, which is exceptionally clearly written, would well serve the purpose of teaching such matter. Some good examples are provided, with solutions at the end of each chapter; this is an additional recommendation in a book of a purely theoretical character. R. G. COOK

Pétroles naturels et artificiels

Par J.-J. Chartrou. (Collection Armand Colin: Section de chimie, No. 124.) Troisième édition, entièrement refondue. Pp. 224. (Paris: Armand Colin, 1952.) 260 francs.

THIS typically neat, paper-covered little volume, which fits the pocket comfortably, is the third edition, No. 124, of "Collection Armand Colin (Section de Chimie)". The author endeavours to cover a wide field of petroleum technology in 224 pages, size $6\frac{1}{2} \times 4\frac{1}{2}$ in. He states his object at the outset: to study physical and chemical properties of petroleum; exploitation and refining; a chemical industry based on petroleum products; substitute hydrocarbons and lubricants. Actually, he goes much farther than that curriculum, ambitious though it is for small space. Twelve chapters describe composition, chemical, physical properties of petroleum; geology, surface indications and exploration; exploitation by drilling, wells, shafts, galleries; storage, transport; refining; analysis, control of products; economic applications of products including chemically derived materials; world production; hazards in the oil industry. There is an afterthought on *osokerite* and asphalt (two pages!); and an omnibus chapter, which includes oil shales, low-temperature carbonization, hydrogenation and synthetic products, completes the study. To me it seems a herculean task to attempt to cover in narrow compass all aspects of such a highly integrated and specialized technology as petroleum as it exists to-day, even in title. At best, it means synopsis; at worst, much severed outline. To the layman, much of this text is beyond him. To student or oil technologist, modern literature is now prodigious in its specialized subjects, and outlines as such are outmoded. Maybe there is a 'midway' public in French-speaking countries to which this little work will appeal; to this extent I wish it well. H. B. MILNER

THE AMATEUR SCIENTIST IN BRITAIN (2)*

By R. BRIGHTMAN

IN the physical sciences the amateur is still rendering services. Maurice Gorham, former head of the Television Service of the British Broadcasting Corporation, has pointed out that broadcasting owes its resuscitation in the 'twenties to the amateurs¹. Their activities, enthusiasm and incessant demands, culminating at the end of 1921 in a petition to the Post Office from sixty-three societies representing 3,300 amateurs asking for wireless telephony transmissions, "primarily to serve the scientific purpose of improving the receiving arrangements", but referring to weather reports, news, etc., which were already being received from foreign wireless stations, in a way that showed clearly that what they wanted went beyond purely scientific tests. This time the Post Office yielded and authorized the Marconi Company to broadcast speech and music for the amateurs, to the extent of one programme of fifteen minutes duration each week, and thus the first authorized broadcast made from Writtle on February 14, 1922, is due mainly to the activities of amateurs. At the present day, a new organization, to be known as the Radio Amateur Emergency Network, is being formed. When it is complete it will include some fifty key stations and about four hundred auxiliaries, all operated by amateurs. Most of the key stations are already linked. The amateurs operating the fifty key stations have all undertaken to provide emergency sources of power independent of the public electricity supply.

Again, Sir Edward Appleton has borne witness to the value of the pioneer work of D. J. Heightman and other amateurs in connexion with solar-radio noise². Attention, he points out, was first attracted to this phenomenon by the reports of wireless amateurs who, round about the period of the last sunspot maximum, noticed the existence of a curious hiss in their receivers on wave-lengths of about ten metres, which they found to occur in day-time only, and to be associated with periods of solar activity. During the War, with the more sensitive and more directional ultra-short-wave receivers in operation, many further reports of the reception of this noise became available, and Sir Edward Appleton used the period of pronounced sunspot activity, January 30 to February 14, 1946, to make a special detailed study of the phenomena. His examination of the evidence available confirms the theory he and J. S. Hey had already advanced that the noise is due directly to ultra-short-wave electromagnetic radiations, which originate in active areas on the sun, and travel from the sun to the earth with the speed of light.

The intense radio-wave emissions from sunspots were also first recorded by war-time operators on Army G.L. equipment. When the V2 rocket bombardment of London began, every method of giving even a few seconds warning was explored. Among these, radar equipments used by Anti-Aircraft Command were modified in the hope that the rockets would give a transient radar echo as they travelled high up in the atmosphere³. They did, but it was soon found that short-lived echoes were obtained

and warnings given when no rockets were about. These spurious echoes were studied by J. S. Hey and his colleagues in the Army Operational Research Group, who eventually concluded that they were caused by meteors in the earth's atmosphere.

It is, of course, scarcely correct to ascribe such work to purely amateur effort. It is unlikely, for example, that anything would have arisen from this latter work had not a fully qualified scientist been responsible for investigating all such unusual occurrences, or had not the members of the Field Study Course been excavating under expert guidance. They do, however, illustrate the force of an observation made by Mr. Justice Lloyd-Jacob in his Bernard Dyer Lecture to the Society of Public Analysts⁴. Mr. Justice Lloyd-Jacob, suggesting that the most promising areas for future scientific growth are those that lie between the various well-established scientific fields, stressed the importance of collaboration of the right kind if these fields are to be developed. What is wanted, he suggested, is not so much the skill to experiment in the field of another scientist, but the competence to understand, to criticize and to appreciate the experiment and the results that the experiment secures. Upon such lines the most useful teamwork was done during the War, and had not secrecy considerations prevented the publication of many of the details of this collaboration, the concepts and characteristics of the scientist would not have remained so unfamiliar to most of his fellow-men. Mr. Justice Lloyd-Jacob observed that some better understanding of the scientist might have saved him from those dangers to which mob hysteria over nuclear-fission appear to expose him. It needs only superficial acquaintance with the outcome of security investigations in the United States, for example, to appreciate how real is the danger to science itself to which Mr. Justice Lloyd-Jacob alludes.

There are other reasons, however, why the wider public appreciation of the scientist and his work is desirable. In the introduction to his "History of the Rise and Influence of the Spirit of Rationalism in Europe", published in 1865, W. E. H. Lecky wrote:

"But when towards the close of the eighteenth century the decline of theological passions enabled men to discuss these matters in a calmer spirit, and when increased knowledge produced more comprehensive views, the historical standing-point was materially altered. It was observed that every great change of belief had been preceded by a great change in the intellectual condition of Europe, that the success of any opinion depended much less upon the force of its arguments, or upon the ability of its advocates, than upon the predisposition of society to receive it, and that that predisposition resulted from the intellectual type of the age. . . .

"The pressure of the general intellectual influences of the time determines the predispositions which ultimately regulate the details of belief; and though all men do not yield to that pressure with the same facility, all large bodies are at least controlled. A

* Continued from p. 565.

change of speculative opinions does not imply an increase of the data upon which those opinions rest, but a change of the habits of thought and mind which they reflect. . . .

"... The doctrine, that the opinions of a given period are mainly determined by the intellectual condition of society, and that every great change of opinion is the consequence of general causes, simply implies that there exists a strong bias which acts upon all classes of men and eventually triumphs over every obstacle."

Mr. Justice Lloyd-Jacob's remarks remind us of Lecky's doctrine of the climate of opinion; but whereas Lecky had in mind particularly the way the discoveries of physical science were entrenching upon the domain of the anomalous and the incomprehensible, and by enlarging our conceptions of the range of law, and revealing the connexion of phenomena that had formerly appeared altogether isolated, had formed a habit of mind far beyond the limits of physical science, we, in our day, are more concerned with the way in which public ignorance or hysteria can limit the operations of science itself.

To take one or two examples:

The Report on the Conservation of Nature in England and Wales, published in 1947, observes¹:

"In the long run the success of wild life conservation must depend predominantly on the completeness with which wild life problems and their implications are known, and on the extent to which public opinion accepts them and therefore gives support to the necessary measures of conservation."

"We are impressed with the futility of pursuing wild life conservation policies which are not widely understood and backed by public opinion, and of creating a multiplicity of offences or restrictions upon the liberty of the individual, in order to curb the misguided activities of very small sections of the population."

Similarly, Sir Arthur Tansley recorded the view that the establishment and fruitful functioning of national Nature reserves and a biological service would not be secured without a greatly increased permeation of the general mind with the outstanding importance of their objects.

Dr. E. A. R. Ennion, addressing in August 1950 the Conference of Delegates of Corresponding Societies at the British Association meeting in Birmingham, likewise observed²:

"Reserves cannot be administered properly by remote-control committees whether of strictly scientific or of predominantly sentimental composition. Still less could reserves be supervised successfully from a window in Whitehall. Their ultimate safeguard lies in the studied care and vigilance of amateur field naturalists up and down the land."

In August 1951, Dr. D. A. Allan³, surveying the "Scottish Scene" in his presidential address to the same Conference at Edinburgh, remarked that the trained biologist required to supervise Nature reserves and to carry out ecological research involved, needed the support of "a special Home Guard of local amateur naturalists, including botanists, entomologists, ornithologists and zoological specialists".

Besides this scientific and practical aspect which obviously calls for a real effort at education, there is a cultural or spiritual aspect which is no less important. As the Huxley Committee observed⁴, the educational benefits to be had from a constructive wild-life policy extend beyond the cultivation of a

healthy public opinion and the technical training of science students to the wider sphere of general and adult education. In this context there is a quotation from the third report of the Nature Reserves Investigation Committee: "A serious student, whatever his calling, who could visit and have intelligently demonstrated to him even a good example of the sites here proposed, would have received a liberal education in one of the most stimulating and formative fields of thought". By building up an appreciation of the interest and beauty of Nature and public consciousness of the aims of conservation, the Huxley Committee considers that the adult educational facilities provided in the Nature reserves would complement and ease the work to be done in National Parks. Now that the Nature Conservancy is well established, it can be confidently expected that, with Mr. E. M. Nicholson as its director-general, who is probably even better known as an ornithologist than as the senior Civil servant who had been secretary to the Lord President's office since 1945, there will be no failure to cultivate the amateur's support and co-operation, and that the Conservancy will encourage and, where possible, extend voluntary efforts in the field of research, especially ecological research, for which it is responsible.

This is not all, however. Prof. S. W. Wooldridge has stated that at no time did the youth of Britain need more greatly to be shown the mental stimulus combined with solace of mind and spirit which come from learning to read and understand the country⁵. It is of vital importance that interest in Nature and in living things should be stimulated and encouraged by every possible means. Only by strengthening this side of people's minds can we hope to counter excessive preoccupation with stark mechanism and the crude materialism to which it often leads—so dangerously characteristic of modern civilization—by a deeper understanding of living beings and of life. Sir Arthur Tansley⁶ also has urged that this is as important to the continuation of civilization as an ever-deepening understanding of Nature and of the complex structure and working of her productions is the very foundation of most of man's practical activities—in the first place his own physical and mental health, then agriculture and the care of animals, and then such pursuits as forestry, control of pests, water supply, drainage, and so on.

The work of the Council for the Promotion of Field Studies, formed in December 1948, largely on the initiative of Mr. F. H. C. Butler, its present director, is appropriately considered in this context. Briefly, the aims of this Council, which was incorporated on June 13, 1946, are to provide facilities for every aspect of field-work at first hand, and to set up for this purpose residential field-study and research centres, distributed throughout the country, in localities selected for the richness and variety of their ecological features, geological and geographical interest and archaeological and historical importance. The field-centres are available alike to all serious workers in the field, whether amateur or professional, whether as individuals or as members of a class from a school, training college or university; from a county college, technical college or youth service; whether as independent workers or as members of a research team, learned society or other corporate body. The Council wishes to co-operate closely with local societies and field clubs, and through the centres should also be able to play an important part in the training of the community in sound knowledge,

aesthetic appreciation and proper use of the countryside. The centres are intended just as much for the individual "amateur nature lover" as for parties from universities, training colleges and schools; in fact, it is one of the aims of the Council to encourage and help the ordinary person with an interest in some branch of natural history who wishes to learn more of this or allied subjects. It is precisely because they are not directly concerned with education that 'amateurs' contribute to a mixed party the spirit of genuine interest and enthusiasms which has nothing to do with examination results. Their contribution to any course is correspondingly valued. They are so often people of wide experience that they have a special contribution to make to discussion and argument on any course, and the work of the centres suffers accordingly when there is none in residence.

Since the first of the field-centres opened its doors at Flatford Mill in May 1946, more than 15,000 resident students have passed through them and the amateur naturalist has been accepted on a really large and comprehensive basis. There are at present four such centres situated in totally contrasting types of country. Flatford Mill itself is specially well placed for the study of hydrobiology, and it is hoped here to develop besides long-term recording of hydrobiological conditions, including temperature changes in a slow-moving river, a training ground for ecological research. The Juniper Hill Field Centre, near Dorking, offers opportunities for the geographical interpretation of landscape, the siting and growth of settlements, plant and animal ecology and general nature study on the North Downs, the western Weald and the outer fringe of the London basin. The Dale Fort Centre, near Haverfordwest in Pembrokeshire, is particularly adapted for the study of bird life and marine biology and the ecology of a rocky coast. It offered in August 1952 for family parties, as an experiment, a holiday course based on the wind and the sea. An integral part of this Centre is the Skokholm Island Bird Observatory. The Malham Tarn Field Centre near Settle offers opportunities for the study of bird life and mammal life in characteristic limestone regions of the Yorkshire dales, including also courses on insects and on fungi, liverworts and mosses. One feature of the work at this Centre has been the annual collaboration since 1950 of the Royal Meteorological Society in a course held in September, and each of these four centres estimates the students in residence, generally for a week at a time, at 1,000-1,200 for the season.

While the need for facilities for field-work in Britain is thus increasing and the opportunities which the Council can offer are more important year by year, the Council finds increasing difficulty in maintaining its centres. It has already been compelled to raise its weekly charges to students to five and a half guineas, and although some firms like Imperial Chemical Industries, Ltd., have made substantial annual grants under deed of covenant in favour of the Council, much more support is required both from industry and from the scientific societies and other bodies if all the possibilities which the Council's work offers for encouraging the activity of both the professional and the amateur scientist in field studies are to be utilized to the full.

It should be apparent from the foregoing account that already much is being done in Great Britain to close the gap between the professional scientist and the amateur, or indeed the layman generally. In few

countries have amateur naturalists made such important contributions to biological knowledge over so long a period as in Great Britain, but since the War there have been remarkable developments in other countries. In a paper reviewing the tenth International Ornithological Congress at Uppsala in 1950, where the large British party included characteristically strong amateur elements, Dr. Julian Huxley referred to the way the interest of the amateur in ornithology had been enlisted since the previous Congress in 1938. Besides the founding of the British Trust for Ornithology, which carries out various scientific investigations almost wholly from the efforts of amateurs, the Swedish Ornithological Society had grown to more than 1,500 members, mostly amateurs, since its foundation in 1946, and there have been similar developments in the United States, Holland and elsewhere. As a result of this, many men and women who would, at best, have become amateur bird-watchers or sentimental bird lovers, have become interested in the scientific aspects of bird life, and have had the satisfaction of helping in research and the advancement of scientific knowledge. Dr. Huxley instances important new knowledge, for example, on the fluctuation in numbers of particular species (like the common heron or the great crested grebe) within a country or region over a period of years, or the relation of clutch-size and of egg and fledgling mortality to geographical position and climatic variation, as discovered only through the co-operative efforts by amateurs. The British Trust for Ornithology itself, which exists to encourage observation by amateurs and to publish the results, has, in addition to the inquiries it has completed into the numbers and habits of rooks, the decrease of the corn-crake and the distribution of the woodcock, for some years been investigating the changes in the population of heronries in relation to the weather and the remarkable spread of the fulmar. The new Observatory on Bardsey Island, off the Llyn Peninsula of Caernarvonshire, which is now making an appeal for funds on the lines adopted by the Fair Isle Bird Observatory of Northern Scotland, is the latest of twelve such observatories to be established in the British Isles, and the fourth along the west coast. It owes its foundation to the initiative of the West Wales Field Society and the Birmingham and West Midland Bird Club, and will offer opportunities for work by amateurs, particularly in setting up the bird-catching traps and devices for the capture, marking with numbered leg-rings, and release of migratory birds.

In the United States in 1938 the Carnegie Corporation and the American Philosophical Society set up a Committee on Education and Participation in Science which surveyed the activity of more than seven hundred amateur scientists in the Philadelphia region and helped organize a number of research projects in which very many more participated. Out of this came "The Amateur Scientist", a book written by the secretary of the committee, W. Stephen Thomas. At about this time, too, a Committee on Private Research, also supported by the Carnegie Corporation, was set up at Western Reserve University for work in the Cleveland area. Many of the studies of amateurs with which it was concerned were in the sciences. The activities of this committee are described in a book by its director, William S. Dix, entitled "The Amateur Spirit in Scholarship". The War unfortunately prevented an extension of

these promising experiments. The American point of view is also well indicated in the presidential address to the American Association for the Advancement of Science of E. W. Sinnott, in December 1949¹⁷. In that address, entitled "Ten Million Scientists", Dr. Sinnott pointed out that we sometimes forget the vast areas where facts and principles of great scientific value may be discovered with no more complex tools or techniques than are at the command of any intelligent layman. He instanced the exact distribution of plant and animal species, the records of flowering dates, the analysis of tree-ring chronology, the variability of wild species, bird censuses and the records of bird and insect migrations, the study of peat borings, the collection and identification of fossils, the distribution of minerals, detailed local weather observations, records of meteorites and of variable stars, time-lapse photography, and problems of radio transmission, as but a few of the many fields open to study by the amateur scientist, and he added that a fresh point of view and freedom from bias have often led the amateur to discoveries that his more inhibited professional brother had overlooked.

The latest Directory of Natural History Societies lists some 124 such societies in Great Britain. Some societies, such as the Geologists' Association, Geographical Association, Amateur Entomologists' Society, Radio Society of Great Britain and British Astronomical Association, have among their members a considerable proportion of young people. The Amateur Entomologists' Society has some two hundred members in a special category of junior membership, and the Radio Society of Great Britain has about five hundred. The Royal Society for the Protection of Birds, besides having a special subscription for those under twenty-one, organizes a Junior Bird Recorders' Club. This was founded in 1943 and has now three thousand members between eleven and eighteen years of age. Members record observations of birds, which are used in producing an Annual Bird Report. Altogether there are some four hundred societies in Great Britain the interest of which include one or more branches of science, and these have already co-operated in such matters as the Land Utilization Survey; British Museum (Natural History), bird-ringing scheme, insect immigration scheme; London Natural History Society, bird report; Royal Meteorological Society, phenological report; Rothamsted Experimental Station and National Institute for Agricultural Botany, crop experiments.

With the growing dependence of scientific work upon State, or at least public rather than private support, it is more than ever important to secure such a public understanding and favourable climate of opinion if scientific work is not to be liable to continual and frustrating interruptions at every time of financial stringency. A volume of studies and sketches which Prof. J. Simmons published in 1952 under the title "Parish and Empire"¹⁸ constituted an eloquent plea for field research and historical approach over a wide range of what may be termed local studies. He directs attention, for example, to the general neglect of industrial history and shows how parish studies can be linked up with national and imperial history. He indicates how the study of local history can contribute not merely to the clearer understanding of some of our modern problems, but also to redress some of the dangers inherent in specialization to-day. Local studies of this type

could make their own contribution to the promotion of a wider general understanding in the community of the nature of scientific work and thus indirectly to the creation and maintenance of the conditions in which scientific activities truly flourish. That, as has been indicated, is one essential element in securing the continuous public support which the effective prosecution of scientific effort under the conditions of to-day demands. It is fostered also by the very existence of the amateur scientist and his wide distribution among all sections of the community. Lastly, as for the past three centuries, the contribution of the amateur is important in itself: even to-day, without the help of the amateur scientist the prosecution of research on the scale desirable into many problems of ornithology, meteorology and other problems embraced in ecology would be impossible. In such fields, with Britain's limited resources of scientific man-power, the co-operation and enthusiastic support of the amateur scientist are indispensable for the most effective deployment of our trained professional scientists.

- ¹⁷ Gorham, M., "Broadcasting and Television since 1900", 84 (A. Dakers, Ltd., London, 1952).
- ¹⁸ *Phil. Mag.*, 37 (7), 73 (1946).
- ¹⁹ Lovell, A. C. B., *Manchester Guardian* (Nov. 10, 1948).
- ²⁰ *Analyst*, 77, 224 (1953); cf. also Mather, K. H., "The Problem of Anti-scientific Trends To-day", *Science*, 118, 535 (1952).
- ²¹ "Conservation of Nature in England and Wales", *Omd.* 7122, 110, 116 (H.M.S.O., 1947).
- ²² *Advancement of Science*, 7, 285 (1950).
- ²³ *Advancement of Science*, 8, 279 (1951).
- ²⁴ "Conservation of Nature in England and Wales", *Omd.* 7122, 13, 19 (H.M.S.O., 1947).
- ²⁵ "The Spirit and Significance of Field Work" (O.P.F.S., 1948).
- ²⁶ "Education for Field Study" (O.P.F.S., 1947).
- ²⁷ cf. also *Nature*, 167, 712, 757, 801, 886 (1951).
- ²⁸ "Birds and Science," *Countryside* 14/5, 108, 267 (1950).
- ²⁹ Thomas, W. S., "The Amateur Scientist" (W. W. Norton and Co., New York, 1942).
- ³⁰ "The Amateur Spirit in Scholarship" (Western Reserve University Press, Cleveland, 1943).
- ³¹ *Science*, 111, 123 (1950).
- ³² Simmons, J., "Parish and Empire: Studies and Sketches" (Collins, London, 1952).

THE OLDEST DATED MINERALS OF THE RHODESIAN SHIELD

By PROF. ARTHUR HOLMES, F.R.S.
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FOR some years it has been suspected that the Rhodesia-Tanganyika Shield might include some of the oldest rocks of the African continent¹. This has now been confirmed by the dating of monazites supplied by Dr. A. M. Macgregor and the Director of the Geological Survey of Southern Rhodesia. Through the good offices of Dr. F. H. Burstall, these minerals have been analysed chemically at the Chemical Research Laboratory, Teddington, for lead, uranium and thorium, and samples of pure lead iodide prepared from each. The proportions of the isotopes in the lead of these samples have been determined by Messrs. William C. Erickson and John Hoffmann in the laboratory of Prof. Alfred O. Nier at the University of Minnesota. The generous collaboration of these friends and fellow-workers is gratefully acknowledged.

The analytical data are recorded in Table 1, together with the crude, uncorrected ages, as read from Wickman's graph². The highest uncorrected

Table 1

(Analyses by the Chemical Research Laboratory, Teddington).

	Pb	U	Th	Pb(U+Th)	U/(U+Th)	Uncorrected age
1.	0.84	0.074	2.30	0.188	0.03	2,630 m.y.
2.	0.96	0.19	9.36	0.100	0.02	2,020 m.y.
3.	0.68	0.09	8.15	0.070	0.01	1,500 m.y.

1. Monazite from pegmatite, Ebonite Tantalum Claims, Bikita District, Southern Rhodesia.

2. Monazite from pegmatite, Jack Tin Claims, north of Salisbury, Southern Rhodesia.

3. Monazite concentrate from alluvium derived from "Lower Basement" rocks, Irumi Hills, about 90 miles east of Broken Hill, Northern Rhodesia.

age, that of the Bikita monazite, 2,680 million years (m.y.), needs very little correction, which is a highly satisfactory result in view of the extreme age of the mineral.

The first published indication of the great age of the Southern Rhodesian pegmatites was provided by Ahrens², who found the mean 'ages' of nine lepidolites, as determined by the strontium/rubidium spectrochemical method, to range from $1,900 \pm 200$ to $2,950 \pm 300$ m.y. Four of the specimens, including the 'oldest', were from the Bikita District, the mean of nineteen determinations (ranging from 1,700 to 3,800 m.y.) being $2,400 \pm 200$ m.y. It is stated that all these measurements were calibrated in terms of a standard lepidolite from south-east Manitoba, the age of which was taken as 2,300 m.y. This value is almost certainly too low, 2,500 m.y. being more probable⁴. Adopting this figure, the mean of all Ahrens's Bikita results is increased to 2,700 m.y. The close agreement with the corresponding lead age is of great interest; but the wide range involved (1,980–3,750 m.y.) emphasizes Ahrens's own warning² that as yet the strontium ages "of these most ancient rocks should not be taken too rigorously". In addition to the random errors inherent in spectrographic analysis, there appears to be, *inter alia*, a systematic error leading to abnormally high 'ages', the source of which is now being actively sought. The discrepancies cannot be altogether due to the original presence of inherited strontium, for even mass-spectrometric methods give results that are manifestly too high; for example, for lepidolite from Pope's Claim, Southern Rhodesia, belonging to the same cycle of

plutonic activity as the Bikita minerals, an 'age' of 3,740 m.y. has been claimed⁴, whereas Ahrens's estimate for lepidolite from the same locality was only $2,150 \text{ m.y.} \pm 10$ per cent. (Since this article was completed, Prof. J. T. Wilson has informed me that the age of microcline from Pope's Claim has been determined in his laboratories at the University of Toronto from the ratio of radiogenic lead-207 to radiogenic lead-206 and found to be $2,600 \pm 100$ m.y. I am indebted to Prof. Wilson for permission to announce this important result.)

The older rocks of Southern Rhodesia are curvilinear synclinal schist belts enwrapped by migmatites and granites. Three systems have been distinguished in the schist belts: (1) the *Sebakwian*, characterized by granulites and metamorphosed ultrabasic rocks; followed, after folding, granitization and erosion, by (2) the *Bulawayan*, characterized by banded ironstones and volcanic rocks, including pillow lavas; followed in turn by (3) the *Shamvaian*, a mainly sedimentary system which, together with the older rocks, was later folded and locally granitized. A suite of pegmatites of lepidolite-greisen type with a lithium, beryllium, tin, tantalum, tungsten mineralization is associated with the later granites. Of many of the mineralized pegmatites it is only known by direct evidence that they are post-Bulawayan, but since some of them cut the Shamvaian formations and the others have not been metamorphosed, it is probable that the whole suite is post-Shamvaian⁵.

The Bikita monazite (Table 2) is a concentrate from a post-Bulawayan tantalite-bearing pegmatite situated about four miles south-west of the main Bikita tin field⁶. If the proportion of lead-204 can be regarded as negligible, the four 'ages' are in remarkably close agreement. If an extreme correction for original or inherited lead be made, taking lead-204 as 0.0007, the four 'ages' become (respectively as in Table 2):

$2,600 \pm 30$; $2,870$; $2,615 \pm 15$; $2,640 \pm 25$ m.y.

The sequence of the first three⁶ indicates a very slight deficiency of uranium, which might be due to natural alteration of the mineral or to a slight error in the analysis. In neither case would this affect the

Table 2

(Isotope proportions determined by William O. Erickson and John Hoffmann in the Laboratory of Prof. Alfred O. Nier)

1. Monazite, Ebonite Claims, Bikita, S.R.				
Isotope proportions	Pb ²⁰⁴	Pb ²⁰⁶	Pb ²⁰⁷	Pb ²⁰⁸
Radiogenic lead (per cent)	< 0.0007	1.000	0.180 ± 0.004	9.35 ± 0.09
	—	0.032	0.006	0.307
Lead isotope ratios	Pb ²⁰⁷ /Pb ²⁰⁶	Pb ²⁰⁸ /U	Pb ²⁰⁷ /U	Pb ²⁰⁸ /Th
'Ages' in m.y.	0.18	0.433	0.073	0.123
	$2,680 \pm 30$	2,675	$2,680 \pm 15$	$2,645 \pm 25$
2. Monazite, Jack Tin Claims, North of Salisbury, S.R. (headings as in No. 1)				
Isotope proportions	0.00489 $\pm$ 0.00004	1.000	0.223 ± 0.001	12.04 ± 0.04
Original lead*	0.00489	0.060	0.067	0.154
Radiogenic lead	—	0.940	0.166	11.886
Radiogenic lead (per cent)	—	0.067	0.012	0.851
Lead isotope ratios	0.177	0.354	0.063	0.091
'Ages' in m.y.	$2,650 \pm 10$	2,500	$2,470 \pm 10$	$1,940 \pm 5$
3. Monazite, Irumi Hills, N.R. (headings as in No. 1)				
Isotope proportions	0.0123 $\pm$ 0.0003	1.000	0.3215 ± 0.002	16.04 ± 0.08
Original lead	0.0123	0.156	0.1759	0.40
Radiogenic lead	—	0.844	0.1456	15.64
Radiogenic lead (per cent)	—	0.028	0.006	0.523
Lead isotope ratios	0.173	0.313	0.064	0.064
'Ages' in m.y.	$2,620 \pm 10$	2,040	$2,330 \pm 15$	$1,390 \pm 10$

* For the original lead that existed about 2,600 m.y. ago, the isotopic constitution adopted is 1.12:7:14.8:32.8

OBITUARIES

Dr. F. M. Penning

age calculated from the ratio of lead-207 to lead-206, which may therefore be accepted as a minimum value. Apart from the standard deviation, one can only conclude that the age of the Bikita monazite is less than 2,680 and more than 2,600 m.y., suggesting that the most probable age is about 2,640 m.y., as given by the ratio lead-208 to thorium.

The monazite from the Jack Tin Claims (Table 2) is a concentrate from a post-Bulawayan pegmatite worked for tin and tantalum north of Salisbury. The 'age pattern' in this case clearly points to loss of lead⁹, in which case the most reliable age is that given by the ratio lead-207 to lead-206, namely, $2,660 \pm 10$ m.y.

The monazite from the Irumi Hills of Northern Rhodesia (Table 3), near the southern extremity of the Katanga pedicle, is a concentrate from alluvium derived from the rocks of the "Lower Basement" Group. Although nearly all the crystals are clear and apparently unweathered, the 'age pattern' indicates that the mineral has, in fact, been considerably altered. Loss of lead is the dominant effect, accompanied in this case by subsidiary loss of uranium. The only age indicator of value is the ratio lead-207 to lead-206, which remains unaffected by recent weathering and would be only slightly reduced by alterations that occurred long ago⁹. The age given by this ratio, $2,620 \pm 10$ m.y., may therefore be a trifle less than the true value. The accordance of this result with those recorded above adds convincing support to Guernsey's provisional suggestion—based on lithological and tectonic similarity—that the Lower Basement rocks of Northern Rhodesia may be partially equivalent to the Bulawayan System¹⁰.

The Bulawayan rocks represent sediments and lavas that were deposited or erupted at the earth's surface considerably earlier than the period of pegmatite formation here dated at about $2,640 \pm 40$ m.y., especially so if the pegmatites concerned are post-Shamvaian, as is highly probable. Since these pegmatites are not only the oldest dated examples known in Africa but are also the oldest yet recorded for any continent, it is interesting to direct attention to their bearing on the time during which life is known to have existed on the earth. In 1935, Dr. A. M. Macgregor detected algal structures in graphitic limestone (33 miles north-north-east of Bulawayo) associated with cherts and lavas low down in the Bulawayan System, which at that time was known as the Greenstone System. In 1941, the structures were described and figured¹¹. This important discovery by Macgregor, and the age determinations now recorded, provide indubitable evidence that life has existed for at least 2,600 m.y. and probably for considerably longer than 2,700 m.y.

FRANS MICHEL PENNING was born on September 12, 1894, at Gorkum in The Netherlands. He studied physics at the University of Leyden under Kamerlingh Onnes, and his thesis on isopycnic curves of gases at low temperatures is in keeping with the Leyden traditions of those days. In 1924 he joined the research laboratories of the Philips Company at Eindhoven, and there he remained until his death on December 6, 1953, devoting his activities almost exclusively to the study of the electric discharge in gases, a field in which he soon became a prominent figure.

A characteristic feature of his work was his continual effort to obtain reproducible results under well-defined conditions. With great skill and patience he carried out a number of carefully designed experiments to determine fundamental constants relating to discharges in gases. This work also led to brilliant new discoveries.

Penning was the first to recognize that the breakdown potential of inert gases can be profoundly modified by small quantities of other gases which may become ionized by collision with metastable atoms of the original gas. This concept enabled him not only to explain the discrepancies between existing data but also to discover a number of new and striking phenomena.

A second aspect of his work dealt with discharges in magnetic fields. One of his results was that, in a magnetic field with a certain electrode configuration, a discharge can subsist at very low pressures. This led to the development of the Penning type of ion source and of the Penning ionization gauge, both of which are valuable tools in modern experimental technique.

In the years after the Second World War, Penning made further important progress in obtaining reproducible values of the cathode fall on a molybdenum electrode by showing how the influence of oxides and other impurities can be eliminated by an elaborate sputtering technique. This work led also to the development of a new stabilizing tube.

Mention should also be made of his article with de Groot on the excitation of quantum transitions by collisions, in "Geiger und Scheel's Handbuch der Physik" (1930), and of the well-known review article with Pruyvesteyn (*Rev. Mod. Physics*, 1940).

Although handicapped by delicate health, Penning was not only a very hard worker but also a man with broad interests. Those who had the privilege of knowing him personally will remember him as a loyal friend and unselfish colleague, who to a rare degree had attained harmony between his personal faith and his daily life.

H. B.-G. CASIMIR

Dr. N. G. Horner

DR. NORMAN GERALD HORNER, who died on March 7, was editor of the *British Medical Journal* from 1928 until 1946, and for eleven years before that he was assistant editor under Sir Dawson Williams. Dawson Williams was an exacting chief, who was held in awe by his staff and colleagues; but Horner, a man of very different constitution and manner, became his devoted disciple, even to the extent of a (probably unconscious) change of literary

¹ Holmes, A. Rep. XVIII Inter. Geol. Cong. London, 1948, Pt. 14, 254 (1951).

² Winkman, F. H., *Sver. Geol. Undersök., Ser. C, Årsbok* 37 (1945), No. 7 (1944).

³ Ahrens, L. H., and Macgregor, A. M., *Science*, 114, 64 (1951).

⁴ Collins, C. B., Farquhar, R. M., and Russell, R. D., *Bull. Geol. Soc. Amer.*, 66, 1-51 (1954).

⁵ Ahrens, L. H., *Trans. Amer. Geophys. Union*, 33, 195 (1952).

⁶ Nicolayson, L. O., Aldrich, L. T., and Doak, J. B., *Trans. Amer. Geophys. Union*, 34, 343 (1953).

⁷ Macgregor, A. M., *Trans. Geol. Soc. S. Africa*, 54, xxvii (1951).

⁸ Tyndale-Biscoe, R., *Trans. Geol. Soc. S. Africa*, 54, 1 (1951).

⁹ Holmes, A., *Amer. J. Sci.*, 248, 84 (1950).

¹⁰ Guernsey, T. D., *Colonial Geol. and Min. Resources*, 1, 123 (1950); "Mineral Occurrences in Northern Rhodesia" (Salisbury, S.R.L., 1951).

¹¹ Macgregor, A. M., *Trans. Geol. Soc. S. Africa*, 43 (for 1940), 11 (1941).

style. In his early days, Horner—one of those people who have a feeling for words and a sense of their value—contributed lightheartedly to his school magazine at Tonbridge, and to St. Bartholomew's Hospital *Journal*, of which he was editor for a time; but when, after serving in the First World War, he joined the staff of the *British Medical Journal* he quickly acquired its discipline and devoted himself to the precise writing and editorial revision which a scientific journal demands. His use of language was scrupulous, and any infelicity or slovenliness in phrasing he would regard as a form of discourtesy. But he was also a man of businesslike ability and resource, exemplified particularly on two occasions, one of them the general strike of 1926, when two issues of the *Journal* appeared in a very attenuated form indeed, but nevertheless appeared, and the other the occasion in 1941, when the printing office was destroyed in an air raid and the most extraordinary improvisations had to be made.

In the latter years of his editorship the British Medical Association became responsible for a number of special journals dealing with different aspects of medicine. Some eight of these were running by the time Horner left Tavistock Square, and although he did not take a major part in starting them they owed a good deal to his suggestions and to the tradition of responsible editorship which he always followed and which he strove to inculcate in others.

Apart from his editorial work, his interest was in the history of medicine. His M.D. thesis in 1922 was on the growth of general medical practice in England. He was honorary secretary and afterwards vice-president of the Section of History of Medicine of the Royal Society of Medicine. After his retirement he assisted in the compilation of the "Medical History of the Second World War".

Horner was editor during a troubled period which comprised not only a world war but also vital change in the medical profession itself. He was handicapped by ill-health; but he maintained throughout his years of office a great integrity, a desire quietly and without special recognition to serve the profession to which he belonged, and to his colleagues and staff he was invariably sympathetic and ready to give a discerning praise where praise was due.

Prof. P. C. Sarbadhikari

DR. C. P. SARBADHIKARI, the well-known Indian cytologist, who died on December 27 in his fifty-sixth year, was professor of botany and head of the Botanical Department of the University of Calcutta. As a young man he studied under the late Sir John Farmer at the Imperial College of Science and Technology, London, and obtained the D.Sc. of the University of London for a series of researches on the cytology of *Osmunda* and *Doodia*. He also studied for shorter periods at Wisley, Kew, Merton, Berlin-Dahlem, and at the University of Paris under Prof. Guillaumond. In 1925 he was appointed lecturer in botany at University College, Colombo, and later became professor there. In 1947 he went to Calcutta to the post which he occupied at the time of his death.

Prof. Sarbadhikari was the author of numerous papers on a variety of botanical topics. His chief contributions lay in the field of morphology and cytology. Specially notable are his researches on the cytology of apogamy and apospory in ferns. A man of considerable culture, he did much to develop botanical study and research in India.

NEWS and VIEWS

Mathematics at Glasgow: Prof. T. M. MacRobert

PROF. T. M. MACROBERT, who retires in September from the chair of mathematics in the University of Glasgow, has made valuable contributions over the past thirty-five years to the theory of various special functions of analysis. His earlier papers dealt mainly with asymptotic expansions of these functions, and were followed by papers dealing with the addition theorem for Legendre functions, and series and integrals of these functions regarded as functions of their degrees. In 1937 Prof. MacRobert introduced the *E*-function, a generalized hypergeometric function, which has proved extremely fruitful for the study of confluent hypergeometric, Bessel and Legendre functions. His more recent papers are mainly concerned with the study of the properties of the *E*-function. He is the author of a number of well-known treatises on mathematics, of which the best known are "Functions of a Complex Variable" and "Spherical Harmonics". During his twenty-seven years as head of the Department at Glasgow, Prof. MacRobert has seen a large increase in the numbers of his staff and of his students, and it was on his initiative that a major scheme of reconstruction was carried out in 1950, involving the conversion of a large hall into a library and a set of lecture, tutorial and staff rooms. Prof. MacRobert was a member of the group of mathematicians who

founded the Glasgow Mathematical Association in 1927. He has taken a prominent part in all its activities and has been the moving spirit behind the inauguration of its *Proceedings*, which, published with the co-operation of the University Court, were first issued in 1951.

Prof. R. A. Rankin

PROF. MACROBERT will be succeeded by Prof. R. A. Rankin, at present Mason professor of pure mathematics in the University of Birmingham. Prof. Rankin was appointed to the Birmingham chair in 1951 (see *Nature*, 167, 840; 1951).

Cytogenetics in the University of London:

Prof. P. C. Koller

THE University of London has conferred upon Dr. Pao Charles Koller the title of professor of cytogenetics, in respect of the position which he holds in the Chester Beatty Research Institute (of the Institute of Cancer Research, Royal Cancer Hospital). Dr. Koller has successively worked at the Kaiser Wilhelm Institute, Berlin (under Prof. R. Goldschmidt), at Cambridge where he studied genetics under Prof. R. C. Punnett, at the Institute of Animal Genetics in the University of Edinburgh (with Prof. F. A. E. Crew), at the Biological Research Institute, Tihany, as head of the Department of Genetics, and at the

John Innes Horticultural Institution with Dr. O. D. Darlington. He also spent one year in the California Institute of Technology, as Rockefeller Fellow, under Prof. T. H. Morgan. Before the Second World War he was closely associated with Prof. H. J. Muller in an investigation of the cytological effects of ionizing radiations on normal and malignant cells, and was later engaged in research on the effects of mustard gas, lewisite and similar substances for the Committee on Chemical Warfare. Dr. Koller was appointed to the Royal Cancer Hospital in 1944, and to the Chester Beatty Research Institute in 1946, where he has carried out a special investigation of the chromosomal and other abnormalities induced by chemical and physical carcinogens. He is the author of numerous papers in the scientific literature, including a specially notable series on the genetical and mechanical properties of the sex chromosomes in a variety of animal species.

George Newport, F.R.S. (1803-54)

GEORGE NEWPORT, who died a century ago on April 7, 1854, is an impressive example of a man who raised himself from a humble origin to scientific eminence and who, despite his lack of early training, made a number of original and enduring contributions to natural history. Born on July 4, 1803, at Canterbury, the son of a wheelwright, he was from early boyhood fond of reading and drawing and was an ardent collector of insects. Deciding on a medical career, he entered the University of London (University College) in 1832, and three years later became a member of the College of Surgeons. He took up surgical practice in London, but was far too interested in microscopical studies to earn his living. Fortunately he had many influential friends, and in 1847 Sir James Clarke secured for him a pension from the Civil List of £100 a year. A patient, accurate observer and a facile dissector, Newport published several important papers (*Phil. Trans. Roy. Soc.*), and his communication in 1851 entitled "On the Impregnation of the Ovum in the Amphibia", in which he demonstrated that impregnation by spermatozoa is the result of penetration and not of mere contact, won him one of the Royal Society's Royal Medals. Many honours came his way in his short life: he was elected an honorary member of the College of Physicians in 1843, a Fellow of the Royal Society in 1846, and a Fellow of the Linnean Society in the following year, and served as president of the Entomological Society during 1844-45. He died at the early age of fifty-one of a "fever of a typhoid character".

The Scottish Economic Society

THE Scottish Economic Society is the new name of the Scottish Society of Economists, which was founded in Edinburgh in 1897, and was for a long time associated with the name of Prof. Shield Nicholson, its first president. Its revised constitution, with its new name, was ratified at a meeting held in the University of Edinburgh on March 16. The Society's chief aims are to advance the study of economic and social problems on the widest basis, in accordance with the Scottish tradition of political economy inspired by Adam Smith, and to encourage the discussion of Scottish economic and social problems. In furtherance of these aims, it published on March 16 the first issue of its new journal, the *Scottish Journal of Political Economy*, to appear three times a year. Some part of each issue will be devoted

to Scottish affairs, either in articles, or in editorial notes, statistical notes on recent social and economic trends, or reviews or review-articles dealing with recent books or official papers relative to Scotland. But there is no intention to limit the contents of the *Journal* either to Scottish contributors or to Scottish problems. The subject-matter of political economy will be interpreted widely, in the tradition of Adam Smith, and articles on economic theory, economic history, sociology, demography and administration, as well as economic theory, will be considered. It is designed to appeal to a wide audience—not exclusively one of professional economists, but including, for example, historians, business men, bankers, accountants, actuaries, Civil servants, trade unionists, and all serious students of Scottish affairs. Members of the Scottish Economic Society, whose annual subscription is one guinea, will receive the *Journal* without additional charge.

The first president of the new Society is Lord Bilsland, banker and industrialist, and chairman of the Scottish Council (Development and Industry). The vice-presidents are Sir Alexander Gray and Dr. M. T. Rankin, who was a senior office-bearer of the old Society. The editor of the *Journal* is Prof. A. K. Cairncross, of the chair of applied economics in the University of Glasgow, who is assisted by an editorial board consisting of the professors of political economy in the four Scottish Universities and the secretary of the Society, Mr. T. A. F. Noble, lecturer in political economy, King's College, University of Aberdeen. The other members of Council are widely representative of business, banking and professional interests in each University region of Scotland. The treasurer of the Society, to whom applications for membership should be sent, is Mr. David Flint, of Mann, Judd, Gordon and Co., 142 St. Vincent Street, Glasgow, C.2.

Imperial College of Science and Technology, London: Report for the Year 1952-53

THE Government announced, on January 29, 1953, that it intends to provide for the major expansion of the Imperial College of Science and Technology, London, and commenting on this the governing body of the College, in its forty-sixth annual report for the year ended July 31, 1953 (pp. 55; 1953), points out that two aspects have to be considered: first, to decide what is academically most desirable; and secondly, to devise an architectural plan designed to provide the necessary academic facilities, largely by building on land at present used by other institutions for other purposes, without the knowledge when the land will be available to the College builders. The governing body emphasizes its satisfaction at the Government's decision, and in the meantime records the building of a further extension to the Department of Metallurgy, improvements to the John Farmer (botany) building for the Department of Plant Physiology, and the purchase of a further 93 acres of land for the Field Station at Silwood Park, Sunninghill, and of the vacant site at 184 Queen's Gate, London, S.W.7. In view of the success of the lunch-time functions organized to encourage general studies in the College, the experiment is being continued for a further year, as is the joint experiment with the London School of Economics in arranging joint postgraduate studies in technology, economics and administration. Of the 1,653 full-time students (only 47 women), 114 came from foreign countries, 198 from Commonwealth countries outside the

British Isles, and 538 from the British Isles outside a radius of thirty miles from the College. The accumulated excess of expenditure over income has been reduced from £19,152 to £1,458. The usual valuable list of published papers, arranged departmentally, is appended to the report.

Use of Aircraft in Agriculture

In 1952 the Food and Agriculture Committee of the Organization for European Economic Co-operation sponsored a mission to the United States to study the use of aircraft in agriculture, with the view of promoting its development in Western Europe. From its report (Technical Assistance Mission No. 107; O.E.E.C., 2 rue André-Pascal, Paris 16^e) it is evident that great advances in this technique have been made since the Second World War, largely owing to the discovery of new synthetic insecticides and weed-killers suitable for low-volume application, and the availability of adaptable war-surplus aeroplanes. In the United States some seven thousand aircraft, compared with sixty-five in Western Europe, are now in use, chiefly for pest and disease control, seeding and fertilizing. While it is recognized that conditions in Europe, where intensive agriculture prevails, are not entirely comparable with those in the United States, the Committee nevertheless considers that there is great scope for expansion in the use of agricultural aviation both in Western Europe, North Africa and other overseas territories. To put the matter on a sound international basis, it recommends the establishment of a European Agricultural Aviation Centre (possibly under the aegis of the Organization for European Economic Co-operation and the European Plant Protection Organization) and the formation of an association of agricultural air companies to facilitate the exchange of technical information, safeguard standards and promote research. In addition to describing the current uses of aircraft in agriculture in the United States, the report includes sections on the economic, technical and operational aspects of the subject.

Fusarium Studies

In a study of the antagonism of soil micro-organisms, including a considerable number of bacteria and actinomycetes, to *Fusarium oxysporum* f. *lini*, a pathogen causing wilt of cultivated flax, R.-O. Lachance and C. Perrault (*Canad. J. Bot.*, 31, 5, 515; 1953) found that nineteen bacteria and eleven actinomycetes showed some antagonism; of eleven organisms which yielded large inhibition zones on agar plates, six had a fungicidal and five a fungistatic action on the *Fusarium* conidia. Among the nineteen antagonistic bacteria under trial, six induced a swelling of the germ tubes or the production of an appressorium-like structure on agar. Greenhouse experiments have indicated that fifteen bacteria and eleven actinomycetes offered a certain protection to seedlings, some of which reached 6, 12, and sometimes 24 in. in height before showing any signs of wilting. The organisms evidently delayed the onset of wilt symptoms, but failed to protect the plants through their entire growth. R. H. Storer (*ibid.*, p. 693) has reported on the effect of soil moisture on *Fusarium* species. Six species and forms of the genus *Fusarium* show optimum growth and survival in soil at 15 per cent saturation. Optimum soil moisture content for actinomycete growth and survival is similar to that for the *Fusarium* species, whereas that for bacteria is at 75 per cent soil

saturation. The present studies indicate that *Fusarium* spp. are strongly aerobic and that *Fusarium* populations can be greatly reduced by maintaining the soil in a saturated condition in the absence of hosts.

Salt-uptake by Root Tissue Cytoplasm

The relation between the uptake of salt by root tissue, that is, by the cytoplasm, and the external concentration of the salt, has been investigated in some of its biophysical aspects by A. B. Hope (*Austral. J. Biol. Sci.*, 6, 396; 1953). The proportion of a given length of bean-root tissue which appears to reach the external concentration when placed in potassium chloride solutions (the apparent free space) increases as the external concentration is increased. The experimentally determined values of the apparent free space at various concentrations of the medium fit the curves representing the quantitative relations between apparent free space and the external concentration deduced by assuming a Donnan equilibrium between the root cell cytoplasm and the medium at each concentration. Thus the experiments indicate the presence of non-mobile ions (probably anions) in the cytoplasmic phase. The concentration of these ions has been calculated to be of the order of 0.01 mol./l. for both bean and maize root cytoplasm. Mature cells seem to have a higher concentration than those less mature. The relation between uptake of potassium chloride by bean-root sections and the time of immersion has been found to follow Fick's law of diffusion. The apparent coefficient of diffusion for potassium chloride in the tissue has been calculated. A typical figure is 0.07×10^{-5} cm.² sec.⁻¹, about one-twentieth of the value for an aqueous solution for the same concentration. The results of these experiments are discussed in relation to the few existing evaluations by other investigators of the non-mobile ion content of cell cytoplasm.

Bibliography of Natural History

The Society for the Bibliography of Natural History (c/o The British Museum (Natural History), London, S.W.7) is a scientific society instituted for the study of the bibliography of all branches of zoology, botany and geology. The Society publishes a *Journal* containing collected lists of bibliographical papers already published on various branches of natural history; original contributions in regard to the dates of publication of zoological, geological and botanical works; particulars relating to the disposal of the libraries and collections of deceased naturalists; and papers on bibliographical subjects. It is proposed also to publish from time to time in the *Journal* facsimile reproductions of rare or unique works or parts of works on natural history.

Effect of Movement of Surface Masses on the Rotation of the Earth

In a paper on "The Effect of the Movement of Surface Masses on the Rotation of the Earth" (*Mon. Not. Roy. Astro. Soc., Geophys. Supp.*, 6, 8; 1953), Andrew Young refers to the third edition of Sir Harold Jeffreys's "The Earth" (pp. 215-16), where doubt is expressed concerning the validity of the equations of motion governing the variation of latitude. This doubt arises from the view that an observer on the solid surface of the earth cannot observe the changing motion of the whole earth, because the axes fixed in the solid earth do not necessarily continue to coincide with the axes of reference

used in the derived equations. In addition, with the seasonal redistribution of surface masses which gives rise to the forced motion in the variation of latitude, there is associated a seasonal variation of angular momentum relative to the solid earth, and this is responsible for an observable variation in the rate of rotation. Mr. Young shows that in the investigation of the effect of surface mass movements on the general rotation of the earth, the change in the length of the day may be treated independently of the variation of latitude. In addition, the seasonal variation of latitude can be described by the usual equations, but account may have to be taken of corrections for the angular momentum of the surface masses. He derives equations which are based on the assumption of axes of reference fixed in the solid earth, and hence fixed relative to an observer on the solid earth, which disposes of the doubt expressed by Sir Harold. It is claimed that the equations remain valid for secular changes in mass distribution over periods of decades; but for periods of centuries some modifications in the equations may be necessary.

Geological Museum, London

THE Geological Museum in South Kensington has now been opened to the public for ten years—four before the Second World War and six years since. It was thus appropriate that in the February number of the *Museum Journal* Mr. A. J. Butler, assistant curator, should give a brief critical commentary based on experience gained during these years. Attendance at the Museum has risen progressively since the end of the War. Though the Museum is visited by specialized groups of the community, it is estimated that about a quarter of a million went for diverse casual reasons. The success of the regional policy in exhibition is now assured, while the geological globe, the gemstones exhibit and the illuminated geological column are always centres of attraction. Mr. Butler is definitely of the opinion that the well-known dioramas have fully justified their initial outlay. He feels, however, that although the exhibits are arranged on a systematic plan, few visitors follow this but wander from one point to another according to the object which happens to hold their fancy.

Index for 1921-50 of the *Physical Review*

THE original intention of the American Physical Society was to publish a cumulative index to the *Physical Review* every tenth year; but this has never been realized. The first index covered the period from the first issue of the journal in 1893 to 1920. In 1930 the world depression, and in 1940 the Second World War, prevented further publications. However, with the financial assistance of the Office of Naval Research and under the direction of Prof. J. W. Buchta, a cumulative index covering the thirty-year period 1921-50 has now been compiled. It is published in two volumes, an author index of 543 pages and a subject index of 498 pages. Prof. Buchta is the present editor of the *Reviews of Modern Physics*; but during the period covered by the index he was assistant editor of the *Physical Review*.

Library Classifications

IN a letter commenting upon Prof. Purchon's communication (see *Nature*, 172, 940; 1953) on library classification, which he thinks expresses the disappointment felt by others with the Library of Congress Classification, and the Universal Decimal

Classification, Mr. Faquir Chand, of the Department of Library Science, University of Delhi, directs attention to the Colon Classification invented by Prof. S. R. Ranganathan. Mr. Chand points out that during the past ten years Ranganathan and his co-workers in India and Great Britain have evolved several helpful concepts and techniques which have made such classification sufficiently resilient to accommodate new knowledge without disturbing the sequence among old knowledge. The fourth edition of Ranganathan's book "Colon Classification" was published by the Madras Library Association in 1952, and Mr. Chand states that a new quarterly periodical, *Annals of Library Science*, will be published to communicate the findings of the Library Research Circle at Delhi, which is constantly engaged in giving effect to the new concepts and in improving the new techniques.

Statistics and Personnel Management

A PAPER on "Statistics and Personnel Management" was given by Prof. M. G. Kendall at the national conference of the Institute of Personnel Management in Harrogate during October last year, and it has now been published by the Institute (Occasional Paper No. 8; pp. 16; London, 1953; 3s.). It is an unexpectedly sprightly and general account of the subject, for Prof. Kendall has managed in the space of sixteen pages to make clear, if not to define, the essential nature of the statistical method in social applications, to state Pareto's Law and apply it illustratively to a question of wage-fixing, and to indicate ways in which statistics might, and perhaps should, be used in other managerial problems. The pamphlet forms useful reading for sixth forms of schools or first-year economics students.

National Science Foundation: Grants

THE award of a second group of grants during the fiscal year 1954 for the support of basic research and related matters has been announced by the National Science Foundation, Washington, D.C. The grants are a hundred in number and total about 1,045,000 dollars, their purpose being for research in the biological and the physical sciences, and for the support of studies and conferences on science, scientific information exchange, compilation of scientific personnel information, education in the sciences, and travel of American scientists to international scientific meetings. The awards for research are for work in the following fields: astronomy, chemistry, developmental biology, earth sciences, environmental biology, engineering sciences, mathematical sciences, molecular biology, physics, psychobiology, regulatory biology and systematic biology. Tenure of the grants ranges from one to five years, with an average length of 2.2 years.

Physical Society's Handbook of Scientific Instruments and Apparatus

THE Physical Society's exhibition at the Imperial College of Science and Technology (Imperial Institute Road, London, S.W.7) is now a firmly established 'hardy annual' of London's scientific life, the recorded attendance last year being more than twenty thousand, and equally established and an essential requisite for all those who intend to visit the exhibition this year (to be held during April 8-13) is the Society's "Handbook of Scientific Instruments and Apparatus, 1954" (pp. 201+pp. 76 advertisements; from the Society, 1 Lowther Gardens, Prince

Consort Road, London, S.W.7; 6s., or 7s. 3d. by post). But the value of the handbook is not limited to those who will have an opportunity of seeing the exhibition, for within its two hundred-odd pages are to be found a selected account of British instruments and apparatus and scientific and technical books that will serve as a valuable reference work to all those concerned with the physical sciences and technology. The book is arranged in numerical order of stands at the exhibition, and short paragraphs describe each particular item. There are an index of exhibitors' names and a fairly detailed subject index which supply all that is needed to locate any entry. Because of the restriction of exhibition space this year, the Society has been forced to limit severely the number of firms and establishments which it could invite to participate, and in order to compensate for this in some measure a new section of the handbook has been instituted in which firms describe items that would have been exhibited had space been available; this section, which consists of twenty-nine pages, is printed on yellow paper to distinguish it from the other items.

University of London: Appointments

THE following have been appointed to readerships tenable at the Royal Free Hospital School of Medicine, University of London: Dr. D. N. Baron (chemical pathology), formerly senior lecturer in clinical biochemistry in the Middlesex Hospital Medical School, London; Dr. Eleanor J. Zeimis (pharmacology), formerly lecturer in pharmacology in the School of Pharmacy, London. Dr. P. Du Val, formerly senior lecturer in the University of Bristol, has been appointed to the University readership in geometry tenable at University College, London. The title of reader in mathematics in the University of London has been conferred on Mr. T. V. Davies in respect of the post held by him at King's College, London.

Atomic Energy of Canada, Ltd.: Chalk River

IN *Nature* of January 2, we referred to the Chalk River atomic energy establishment as "a closed community engaged exclusively on secret work". Dr. W. B. Lewis, Vice-President for Research and Development, writes that this is not the case. "Almost all research work at Chalk River in pure nuclear physics and in biology is non-secret and less than half of that in chemistry is secret. It is mainly the technological aspects of the plant which are secret. The scientific staff freely discuss their work with colleagues in universities and other laboratories in America and Europe. Some fifty papers on original work are published annually. Lectures are given at universities and scientific institutions by scientists on the staff, and papers are presented at meetings of learned societies such as the American Physical Society, the Royal Society of Canada and the Chemical Institute of Canada. Visitors from other laboratories may come to Chalk River for discussions of non-secret work, subject only to certain reasonable formalities. General interest visits are not encouraged, but visiting scientists number about forty a month. As in Britain, security clearance is a requirement for all staff, because the disadvantages of splitting the establishment far outweigh the possible advantages. Besides basic research, it should be noted that the principal target of Canada's atomic energy programme is atomic power. Although by British standards this plant is geographically remote, it is not, we feel, intellectually isolated."

Announcements

THE University of Sheffield has conferred the title of reader on the following: Dr. J. G. Boswell (plant physiology), at present senior lecturer in botany; and Dr. E. T. B. Francis (vertebrate zoology), at present senior lecturer in zoology.

DR. R. M. WILLIAMS has been appointed director of the Applied Mathematics Laboratory of the Department of Scientific and Industrial Research, New Zealand, in succession to Mr. I. D. Dick, who was recently appointed an assistant secretary of the Department. Dr. Williams was born in Christchurch, New Zealand, and graduated in mathematics from Canterbury College in 1940. After war work, first on radar and then in the United States on the atom bomb, he obtained a Ph.D. at Cambridge and then, in 1949, took up a post as senior mathematician at the Applied Mathematics Laboratory.

THE new building of the Borough Polytechnic, London, S.E.1, will be open for inspection during April 7-9. This building includes laboratories for pure and applied chemistry, biology and biochemistry.

As a result of war damage, etc., the records of University College, London, were much impaired. The College is now preparing a complete list of those who have studied there either as undergraduates or postgraduates or who have been otherwise associated with the academic work there. The College is therefore asking anyone who has been in any way associated with it to write to the Secretary, giving their present addresses and a short statement of their careers with dates.

THE seventh annual congress of the Laboratory Animals Bureau will be held this year in the University of Sheffield during April 5-6. At the end of the first day the Animal Technicians Association will hold its annual general meeting. Further information can be obtained from the Laboratory Animals Bureau, M.R.C. Laboratories, Holly Hill, London, N.W.3.

THE Universities Federation for Animal Welfare is holding an Easter congress in University College, London (Malet Street, London, W.C.1), during April 6-9. The congress is open to all, whether members of the Federation or not, on payment of a fee of 2s. 6d. Full board (£3 3s., or 30s. for students) is available in the College. Further information can be obtained from Miss M. P. Williams, Branch Organizer of UFAW, 284 Regent's Park Road, London, N.3.

THE Development Commission is offering a few grants to British honours graduates for training in research problems in marine or freshwater science, which is designed to fit them for employment either in the Fishery Research Services of the Ministry of Agriculture and Fisheries and the Scottish Home Department or in a marine or freshwater biological research institute. The grants are worth £250-£350 a year, with extra university fees paid, and are tenable from October 1 initially for one year, but renewable up to a maximum of three years. Application forms, to be returned by May 20, can be obtained from the Secretary, Development Commission, 6a Dean's Yard, Westminster, London, S.W.1.

NOMENCLATURE OF VIRUSES

THERE has been much discussion as to the wisdom of applying to viruses binomial names of the Linnaean type, and in particular as to the advisability of doing this over the whole field and forthwith. At the Fifth International Congress of Microbiology held in Rio de Janeiro in 1950, the International Nomenclature Committee, on the advice of its virus subcommittee, held that an attempt to apply binomials to viruses in a comprehensive way is premature; it suggested what criteria could be used in any attempted classification; further, study groups were set up for certain better-known virus groups with the view of determining whether binomials could profitably be applied to such viruses, as a beginning. Study groups were thus set up for the psittacosis-lymphogranuloma group (Chlamydozoaceae), the pox viruses, insect-pathogenic viruses, the viruses related to influenza and those of the arthropod-borne encephalitides.

At a symposium held in New York in January 1952, this piecemeal 'Rio approach' was generally favoured; and two more study groups were set up for viruses related to poliomyelitis and herpes simplex respectively.

At the Sixth International Congress of Microbiology held in Rome in September 1953, the virus subcommittee of the International Nomenclature Committee considered the whole question, having before it the reports of its study groups. Nine animal virologists and six plant virologists were present at one or both of the meetings held. They decided to reiterate the conclusions of the meeting in 1950 that at present "the use of systems of classification for and the application of binomials to viruses as a whole are undesirable and should be discouraged". They also recommended that the starting date for valid Linnaean nomenclature for viruses should not yet be determined, and that until this was done names for viruses already proposed should have no standing in bacteriological nomenclature.

The subcommittee favoured, with one dissentient, the application of internationally accepted names to all viruses. On the other hand, the plant and animal virologists present, polled separately, voted by majorities against the application of Linnaean binomials to viruses at the present time. The feeling of the majority was that such names necessarily carried implications as to taxonomic relationships, and that sufficient evidence as to such relationships was not yet available.

The animal virologists, at a separate meeting, felt that the use of comprehensive systems of nomenclature such as had been introduced in teaching as well as in the literature¹ would not be discontinued unless something else were offered as a substitute. Use of a Linnaean system at the moment would be particularly unfortunate if it led to an undesirable separation of practice between the animal and plant subsections. Other names were therefore put forward of such a nature that their special character was obvious, yet they could later be transferred to the Linnaean system under the International Code. Grouping of viruses should at present start at the generic level (or equivalent).

It was agreed that the report of the Chlamydozoaceae study group should be accepted; this held

that the viruses related to psittacosis were closely related to the rickettsiae and should be considered together with them. This implied their inclusion in Rickettsiales under the bacteriological code and their removal from the sphere of consideration of the virus subcommittee.

A majority vote favoured a uniform system of forming the equivalent of generic names, and rather than forming these from personal names (eponyms), favoured the use of the suffix '-virus' as shown in the appended list. Such a suffix would mark these names as being something apart from the Linnaean system but need not involve change in names if the Linnaean system were later applied to viruses. Names with the '-virus' suffix should be of the neuter gender. Though the names of viruses would be binomials, the terms 'genus' and 'species' would be avoided at present; the terms 'group' and 'group-member' or similar designation being used instead. Such names should, however, be printed in italics in scientific papers, as with Linnaean names, and capital letters would be used for group names. The names would not, however, be ascribed to authors, as under the Linnaean system, and the law of priority would not be applied at the present time. In order, therefore, to avoid confusion, the names under this system should be officially sanctioned by the International Nomenclature Committee or its virus subcommittee. The equivalent of type species should not be designated, but type strains should be deposited with appropriate collections of type cultures. Names in the appended list would be the first to receive such official sanction. The list of approved names of group members should be added to and revised from time to time. Publication of lists of newly approved names should be in the *International Bulletin of Bacteriological Nomenclature and Taxonomy*; but full descriptions of viruses the names of which were approved should be published in other appropriate scientific journals by specialists concerned, with the approval of the virus subcommittee.

The plant virologists, rejoining the discussions, concurred with the principles just outlined, though not committing themselves to the use of the '-virus' suffix or any particular form of 'group' name in their field. Dr. L. M. Black, chairman of the plant virus subsection of the virus subcommittee, was unable to be present; he had not been able to present a report likely to command any general acceptance among plant virologists. Dr. J. Craigie, for the bacteriophage subsection, had submitted a unanimous report which maintained that Linnaean binomials could not at present be suitably applied in the phage field. Of the animal virus study groups, that considering arthropod-borne encephalitides felt that relationships within the group were at present so uncertain that application of binomial nomenclature was premature. Names were agreed to for viruses of the pox, influenza, insect-pathogenic, poliomyelitis and herpes subgroups, based on reports of the various study groups and, in some instances, modified by the main virus subcommittee.

It appeared that plant virologists were much more evenly divided concerning the use of Linnaean binomials than were animal virologists. The use of the '-virus' suffix is proposed now only for animal

viruses. The subcommittee was strongly against any course of action which would prejudice future chances of a common policy for the nomenclature of all viruses, especially now that some viruses have been shown to multiply both in plants and insects. It thought that its recommendation embodied useful positive proposals for animal viruses, and yet did not compromise future parallel action with plant virologists.

A report embodying these conclusions was presented to the main International Nomenclature Committee, which approved its publication in the *International Bulletin of Bacteriological Nomenclature and Taxonomy*. This explanatory note is written in the belief that as wide publicity as possible for the recommendations is desirable.

PROPOSED "NON-LINNAEAN" BINOMIALS FOR SOME ANIMAL VIRUSES

<i>Poxvirus variolae</i>	(smallpox)
" <i>officinalis</i>	(variola)
" <i>bovis</i>	(cow-pox)
" <i>muris</i>	(ectromella, mouse-pox)
" <i>avian</i>	(fowlpox)
" <i>mollium</i>	(molluscum contagiosum)
" <i>myxomatidis</i>	(rabbit myxoma)
<i>Herpesvirus hominis</i>	(herpes simplex)
" <i>zoster</i>	(pseudorabies)
" <i>stuebs</i>	(B virus)
" <i>ovine</i>	(Virus III)
" <i>varicellae</i>	(varicella)
<i>Polliovirus hominis</i>	(human poliomyelitis)
" <i>muris</i>	(mouse encephalomyelitis, FO type)
<i>Myxovirus influenzae-A</i>	
" " <i>-B</i>	
" " <i>-C</i>	
" <i>pestis-pulm</i>	(fowl plague)
" <i>multiformis</i>	(Newcastle disease)
" <i>parotidis</i>	(mumps)

The group name *Myxovirus* for viruses related to influenza was intended to indicate that the viruses in question have a particular kind of affinity for certain mucins.

INSECT-PATHOGENIC VIRUSES

Poliovirus (= *Borrelia*): group members are *P. boumbyi*, *effluens*, *reprensus*, *olearius*, *compesens*, *perceptor*, *fasciiformis*.
Ompovirus (= *Bergoidia*): group members are *O. calypsum*, *ambolus*, *halicticus*, *thompsoni*, *oleorhabdus*, *brassicae* and *noctodes*.
Globovirus (= *Smithia*) *rotundum*.
Morovirus (= *Morator*) *nashum*.

All the names of group members among insect pathogenic viruses correspond to the specific names listed by Bergold¹ and Steinhaus².

C. H. ANDREWS

(Chairman of the Virus Subcommittee,
International Nomenclature Committee.)

¹ Holmes, F. O., in "Bergey's Manual of Determinative Bacteriology", 6th edit. (Williams and Wilkins, Baltimore, 1948).

² Bergold, G. H., *Ann. N.Y. Acad. Sci.*, **55**, 995 (1953).

³ Steinhaus, E. A., *Ann. N.Y. Acad. Sci.*, **55**, 517 (1953).

RADIATION HAZARDS OF ATOMIC ENERGY*

A POWER programme on which a nation's economy rests inevitably has its hazards. Coal-mining is a dangerous occupation; drilling for oil and refining is subject to fire risk. Releasing energy from the atomic nucleus has its own particular dangers, notably from ionizing radiation, and the atomic-energy industry of the future will have to be planned to avoid these hazards. The cost of

safety devices will be great, and it will be the business of statesmen to decide how to balance the economic price of safety against the hazards to health.

Experience with ionizing radiations began more than fifty years ago with the discovery of X-rays and radioactivity. Many of the early investigators fell victim to burns, diseases of the blood and blood-forming organs, and cancer. In 1921 the X-ray and Radium Protection Committee was formed in Great Britain which set national standards of safety. This task has now been taken over by the International Committee on Radiological Protection.

Originally the safety of only a few hundred experimenters had to be considered; but now it is a problem of hundreds of thousands within the atomic-energy industry, and of the population at large. There are two main hazards to consider: those from electromagnetic and corpuscular radiations applied from without, and from radioactive materials taken into the organism.

Nuclear reactors must be enclosed within biological shields to absorb the γ -rays and neutrons. The re-processing of enfeebled reactor fuels and the extraction of plutonium and fission products must be carried out in a way which will minimize the escape of radioactive materials to the atmosphere or in drains. It is impossible, however, to prevent such escape completely and one must budget for a certain liberation of radioactive elements in routine operation, in addition to possible accidents. The question then is what is the radiation dose that can be tolerated.

All ionizing radiation is harmful to living tissue. Nevertheless, evolution has occurred in the presence of a natural background of radiation from cosmic and terrestrial sources, which produce a total dose of about 100 milli-roentgens per year. On the other hand, it is known that large doses have caused death and disease among scientific workers, luminous dial painters and miners in the Schneeberg; these effects can be reproduced by irradiating animals. In addition, radiation can induce unfavourable mutations. Little is known of the effects of radiation in human genetics and one has to infer from genetic investigations on the lower forms of life, where reproduction is rapid, such as the *Drosophila* or the mouse. The phenomenon of increased mutation-rates might be the limiting factor in the ultimate development of atomic power. What one can do at the moment, when still only a small fraction of the population is at risk, is to see that the national population dose of radiation released by man (the product of average dose of those occupationally exposed and the total number exposed) does not significantly exceed the national population dose from natural radiation. This is a form of compromise adopted in establishing the maximum permissible dose, which usually is about one-tenth of the minimum damaging dose to man or experimental animal. Where this is unknown it is calculated from biological or physical data and extra safety factors are added.

One of the main problems is the disposal of fission products. Some can be concentrated to a small volume and made insoluble in water and stored underground or under water until they decay. A small fraction, however, will inevitably escape into the air or into drains, preferably direct to the sea, where the activity will be greatly diluted. If the energy equivalent to the present total coal consumption in Great Britain were obtained from fission, the total activity of, say, strontium-90 would amount to

* Summary of a lecture by Dr. J. F. Loutit, being the fourth of the series of public lectures arranged by the Atomic Scientists' Association and the Department of Extra-Mural Studies of the University of London (see also *Nature*, February 27, p. 386, March 13, p. 477, and March 27, p. 573).

8,500 megacuries. If this were 1 per cent of the world's effluent and it all became uniformly mixed in the sea (of a total volume 1.4×10^{24} c.c.), the concentration would be 6×10^{-7} microcuries per c.c., which is about the permissible activity for drinking water. The sea already contains 3×10^4 megacuries in the form of radioactive potassium, hence there should be no danger if the active effluent is uniformly mixed. Unfortunately, mixing in the sea is subject to weather conditions and there may be 'hot' spots of dangerous activity.

The biological hazards from the fission products depend largely on their chemical and physical states. Iodine, for example, is very important biologically because of its concentration in the thyroid; but it is not a serious problem in routine operations as it decays in a short time. In accidents or bombs, however, it may become a danger if it is deposited in the fall-out. In the Monte Bello test the fall-out contained water-soluble iodine, which was taken up in the thyroid of guinea pigs.

Of the other fission products, caesium behaves like sodium; it is difficult to precipitate and would be expected to be found in water effluent. Tests for its presence in seaweed are being carried out. Barium and strontium, which are relatively soluble, are deposited in bone. The other elements are relatively insoluble in water or the digestive tract, but may be deposited on the lining of the gut.

The activity ingested by domestic animals is also of importance. The fresh vegetable diet consumed by man is small and its radioactivity has a chance to decay in storage. Animals, however, eat large quantities of grass, and superficial contamination of the earth presents an internal hazard to the animal and, consequently, to man eating the meat. The safeguard is again the time factor, and that most of the activity is deposited in bone.

Man receives a relatively larger intake through the lungs than through the alimentary tract. Most of the particles are, however, large enough to be caught up in the filter system of the upper respiratory tract, from which they are finally conveyed to the gut. The most important thing, therefore, is to keep the air clean and uncontaminated. Clean air ensures clean soil, vegetation and water supplies. Use of the sea as a disposal ground must be controlled to avoid contamination of edible fish. The ocean depths may be a suitable dump for concentrated sources until technical improvements in propulsion make it possible to discharge them to interplanetary space.

UNESCO ADVISORY COMMITTEE ON ARID ZONE RESEARCH

SESSION IN MONTPELLIER

THE Advisory Committee on Arid Zone Research, which is a Committee of the United Nations Educational, Scientific and Cultural Organization, held its sixth session in Montpellier during November 3-8, 1953, and the following are the principal recommendations that were made to the Director-General of Unesco.

Symposia. The holding of symposia should be continued, and, when possible, half of them should be jointly organized with other relevant agencies or

scientific organizations so as to achieve closer liaison with them. The Director-General, it is suggested, should accept the invitation of the Indian Government to hold a symposium on "Wind and Solar Energy in Arid Areas" this autumn. Also, the subject for the symposium to be held in 1956 should be the formation and erosion of soils as affected by climatic factors, and this should, if possible, be held jointly with the Food and Agriculture Organization and the World Health Organization.

Review reports. It was decided at the session that review reports should be fewer in number and that they should deal with research subjects rather than consist of surveys of specific geographical areas. Each report ought to be a critical appreciation of work done and not merely a summary of publications. The reports should be published in book form, and, when a symposium is held on the same subject, they should be published, if possible, with its proceedings. The recommendation was made that six reports be obtained dealing with human and animal ecology in arid regions, two being on human ecology and one each on the ecology of mammals, birds, locusts and other insects.

Arid zone fellowships. Candidates selected for such fellowships should be of sufficient seniority and training to obtain adequate benefit, and careful consideration must be given not only as to the best location for the Fellow to work but also as to the person responsible for his studies and the length of his stay in each locality. Each Fellow should submit both interim and final reports on his work to the Committee.

Research projects. The Committee recommended the following procedure to be adopted in the submission of research projects to Unesco, and for their consideration by the Committee. (1) Projects should be submitted after examination by, and with the support of, the national commission of the member State from which it originates. Information should be provided about the suitability of the applicant to conduct or supervise the work, and where relevant as to the relation of the project to other research. If the applicant is a member of a scientific institute, this institute should also give its support. (2) If it feels this desirable, Unesco should obtain further expert advice on the project from among its honorary consultants prior to submitting the proposal to the Advisory Committee. (3) Recipients of Unesco research grants must submit by March 1 and September 1 progress reports for the information of the Advisory Committee. Failure to submit such reports may involve the discontinuance of Unesco support. (4) The Advisory Committee should review current projects and should consider whether to advise continued support for them, before giving advice on the support of new projects.

The Committee also recommended that three criteria should guide the acceptance of projects submitted: the project must directly relate to a specific arid zone problem; it should bear on some principle of general scientific interest; and it should either be of a nature that can be expected to yield results within a period of two years, or be one that can be continued by local support, after initial financial aid from Unesco.

Unesco Symposium of Plant Ecology of the Arid Zone. Following the session of the Committee, a symposium organized by Unesco as part of its arid

zone programme was held during November 7-10 in Montpellier with the help and support of the university there. Speakers from fifteen countries contributed papers under the following sections. (A) Structural and physiological features of the vegetation. This section included papers on ecological classification, the fodder value of desert plants in South Africa, and the effects of land management on arid zone vegetation. (B) Climatic, ecoclimatic and hydrological effects on vegetation. The papers in this section dealt not only with effects of rain and other climatic factors but also with dew measurement and with forests in arid areas. (C) Soil and vegetation. This section covered the effects of soil type, the influence of minor elements and soil microbiology. (D) Influence of other factors. These included overgrazing and soil insects, and a valuable account was given of methods used in Australia in land-use surveys. The symposium as a whole included a number of valuable papers and provoked keen discussion. Its proceedings will be published.

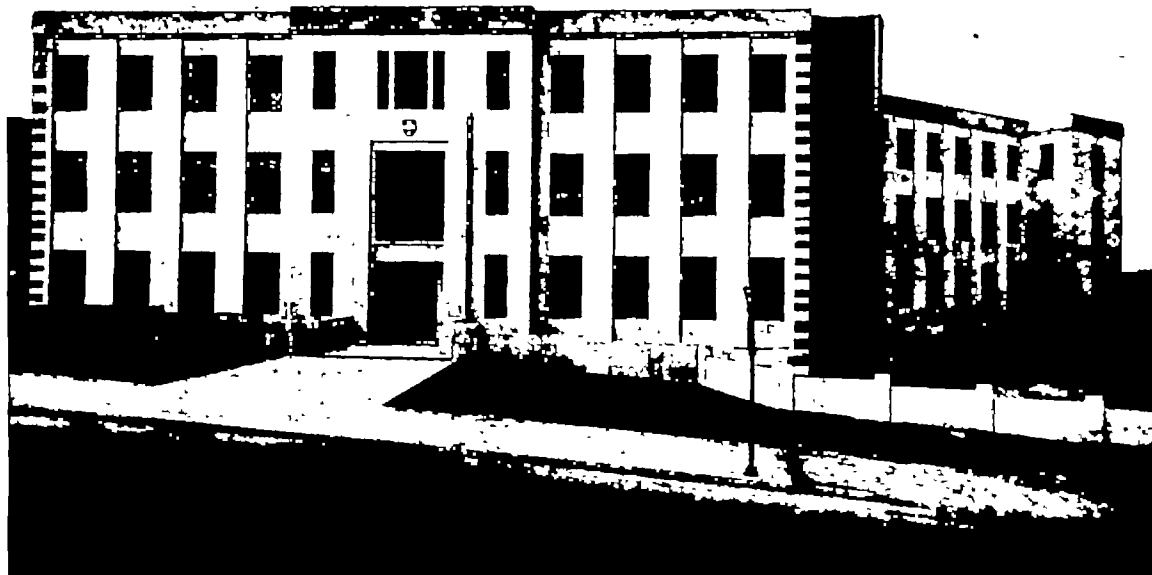
NEW CHEMICAL LABORATORIES OF THE UNIVERSITY OF SHEFFIELD

THE new chemical laboratories of the University of Sheffield were opened on February 5 by the Earl of Scarborough, and afterwards honorary degrees were conferred upon Sir Cyril N. Hinshelwood, Prof. O. K. Ingold and Mr. T. A. McKenna. A single structure now takes the place of laboratories that were formerly separated from one another and from the central stores by a hundred yards horizontally

and as many feet vertically in a building without lifts. While the greater part of the cost has been met by grants to the University for that purpose by the University Grants Committee, the Staveley Coal and Iron and the Staveley Iron and Chemical Companies, in response to the appeal for a University Development Fund in 1947, covenanted to contribute a sum of £50,000 primarily for the benefit of the Chemistry Department. In permanent record of the University's appreciation, the research laboratories in the new Department have been named the Staveley Laboratories.

As the first stage of a larger structure which will be necessary for any significant increase in the present number of students, it consists of a main block facing Brook Hill, with a wing at its eastern end receding obliquely from the street. Provision has been made for additions when necessary at both ends of the block. The four-story building is of steel-framed brick faced with Portland stone; the sloping site allows unrestricted natural lighting to the lowest floor of the wing. The wing consists essentially of four large teaching laboratories, one above the other. From the lowest floor upwards, they are for intermediate classes, advanced inorganic chemistry, physical chemistry and elementary organic chemistry, respectively; each is served by a sub-store connected to the main store by a goods lift. These teaching laboratories have small rooms attached for special purposes, and in addition there are eight research laboratories and seven small rooms for lecturers.

The various floors are united by staircases at each end of the main block and an emergency staircase at the far end of the wing. There is a passenger lift at the junction of the main block and the wing, and provision has been made for another lift at the west end. The junction of the wing and main block, with



New Chemical Laboratories of the University of Sheffield

its lifts and staircase, thus constitutes the main distributory channel for the whole building.

On the lower ground floor of the main block are the central stores, with goods entrance and unpacking area, and separate accommodation for dangerous or excisable materials; here also are the mechanics' workshop, glass-blowers' room, analytical preparation room and micro-analytical laboratory, a laboratory for heavier equipment, and the electrical sub-station and calorifiers serving the building. A basement provides further storage facilities, a constant-temperature room, refrigeration room, and rooms for special equipment.

The main entrance is to the ground floor, which has common-rooms for teaching and laboratory staff and for research students, cloak-rooms, X-ray and spectroscopic laboratories, and the main lecture theatre, which seats 250. This theatre, more than large enough for present departmental needs, is intended to be used also for general university purposes. At the very fully equipped lecture bench are controls governing the window blinds (in sections), the room lighting (in sections), blackboard movement and lighting, and spotlighting of the bench itself. The projection box, in communication with the bench, has 35-mm. and 16-mm. projectors, microfilm projector, lantern and epidiascope.

The Wynne Library, built out from the western end of the ground floor, has been equipped with steel shelving calculated to cope with the menacing expansion of chemical literature for some ten years. It is named in commemoration of the great services to the University of the third professor of chemistry, the late William Palmer Wynne.

Whereas in the completed building the first floor will be entirely devoted to physical chemistry, three of the seven research laboratories in the main block are at present used for organic chemical research. There are also on this floor a reader's room, dark rooms and other small rooms for special purposes, and a lecture theatre with seating for 120. On the second floor of the main block are the professor's room, a reader's room, lecturer's room, four research laboratories, small rooms for special work, a teaching laboratory for advanced organic chemistry, and a small lecture theatre seating 60. Rooms for solvent recovery and for conducting dangerous operations are provided on the extensive flat roof.

As a whole, the building provides working places for some 240 undergraduates at any one time, and, including the teaching staff, for 50-60 research workers. Accommodation for the more elementary classes is multiplied by duplication or triplication of lockers, so that places can be found for as many as 450 undergraduates.

The services in the laboratories include high- and low-pressure cold water, hot water, gas, electricity, steam and compressed air, all carried in readily accessible channels 10 ft. apart, running vertically and horizontally. In addition to the ordinary a.c. supply at 240 V., three-phase current is available at certain points, and d.c. supply is from mobile rectifiers and batteries. Lighting is in general by tungsten lamps in corridors and lecture theatres, but by fluorescent strip, sometimes of 'colour-matching' type, in teaching and research laboratories. Ventilation is by window and by extractor fans—one for each fume cupboard—which work from the roof. The building is heated by hot water provided from the main University station across Winter Street, operating through panels in the walls.

AN ATLAS OF END-GRAIN PHOTOMICROGRAPHS FOR THE IDENTIFICATION OF HARDWOODS

AS the number of hardwood timbers from tropical countries now being placed on the market increases, their identification has become increasingly difficult. The Forest Products Research Laboratory, Princes Risborough, has already produced Bulletin No. 25, "Identification of Hardwoods: A Lens Key", which provides a practical method of timber identification for those lacking laboratory facilities—in other words, for the man out in the forest or in the timber yard. It may not be generally known that, among tropical timbers at least, there may be a close resemblance between a timber of considerable value for structural and other purposes, for example, and another, or more than one, which is of an inferior quality. The fact that the latter exists in greater abundance in the forests and therefore is of easier and cheaper extraction can lead to substitutions which are far from desirable.

The "Lens Key" was prepared for the use of the practical man engaged in the extraction and marketing of these more or less new tropical timbers. To indicate its value to the forest man, an illustration may be given. Whenever possible, water transit is the cheapest and easiest for the transport of heavy timber materials. The felled trees after topping are made up into great rafts and floated down the river until they reach the port or checking station. One or more of the rafts may purport to be of the valuable species of timber of the region. Yet it is simple to include a number of logs of the inferior species, the whole raft being passed for payment on the higher royalty scale. Armed with the "Lens Key", the checking officer is in a position to stop this kind of thing.

The Forest Products Research Laboratory has now produced an addition to the "Lens Key" which can be used in conjunction with it. Bulletin No. 26, entitled "An Atlas of End-Grain Photomicrographs for the Identification of Hardwoods", supplements the "Lens Key" by providing photomicrographs of the timbers dealt with in the latter and enables users to verify their identifications by comparison with photographs of authentic species. As the author says: "it provides a ready means of checking that a timber is what it is reputed to be". Of course, it is to be understood that the user of the "Atlas" must be able to prepare a cleanly cut end-grain surface of the timber in question. A safety-razor blade can be used for the purpose, as it gives a sharper and cleaner cut than a knife.

There are 396 photomicrographs, all beautifully clear reproductions, in the "Atlas" at a $\times 10$ magnification which shows the structure of the timbers dealt with. The arrangement of the photomicrographs according to alphabetical order of botanical families, and within each family similarly according to the botanical names of the timber, is exactly parallel with that adopted for the descriptions of the timbers in Bulletin No. 25. An index giving botanical and common names of the timbers is appended.

* Department of Scientific and Industrial Research, Forest Products Research Bulletin No. 26: *An Atlas of End-Grain Photomicrographs for the Identification of Hardwoods*. Pp. iv+87. (London: H.M.S.O., 1953.) 12s. 6d. net.

KODAIKANAL OBSERVATORY ANNUAL REPORTS FOR 1951 AND 1952

THE annual reports of the Kodaikanal Observatory for the years 1951 and 1952*, both of which have only recently been received, deal mainly with the astronomical work of the Observatory; the meteorological data appear in the *India Weather Review* and the administrative details are to be incorporated in the annual report of the India Meteorological Department. The golden jubilee of the Observatory was celebrated in September 1951, and the event was marked by the inauguration of the newly built Ionospheric Laboratory and of the newly installed 'Bhavnagar Telescope', a 20-in. Cassegrain reflector constructed by Grubb which originally belonged to the now defunct Poona Observatory and named after Maharajah Takhtesinghji of Bhavnagar.

An expedition was organized to observe the total eclipse of the sun on February 25, 1952, and the party of four, led by Dr. A. K. Das, started on December 27, 1951, for the eclipse camp at Ar Ratawi in Iraq. On this expedition, which is referred to in the 1952 report, the observational programme was unfortunately frustrated by bad weather at the time of the eclipse.

International co-operation, including the exchange of spectroheliograms and photoheliograms with foreign observatories, was maintained as usual (a list of these observatories is given); and the daily broadcasts of 'ursigrammes' relating to solar activity, and to issuing warnings for expected ionospheric and geomagnetic disturbances whenever expected, were continued.

A list of the equipment of the Observatory is given in each report, including (a) astronomical and spectroscopic instruments, (b) magnetic instruments, (c) electronic instruments, (d) workshop machinery, and (e) other instruments, with the names of the different instruments in use. The 1952 list shows one more under (a), one more under (b) and six more under (c) compared with the 1951 list. Weather conditions during 1951 were better than those of the previous year, and those of 1952 were better than the 1951 conditions. There was a considerable decrease in sunspot activity in both years. The number of prominences in 1951 showed a decrease of 15 per cent compared with the number in 1950, but there was an increase in the areas of 7 per cent; this was due to greater prominence activity during the second half of 1951. In 1952, prominence activity as represented by areas showed a decrease of 16 per cent, and the numbers an increase of 23 per cent over the 1951 results.

* Kodaikanal Observatory. Annual Report for the Year 1951: pp. 10, 1952; R. 1. or 1s. 6d. Annual Report for the Year 1952: pp. 12, 1953; As. 12 or 1s. (Delhi: Manager of Publications.)

PREHISTORIC SETTLEMENT PATTERNS IN THE VIRU VALLEY, PERU

THE Viru Valley Project was an intensive survey of one of the smaller irrigated valleys of the Peruvian coast. It was mainly archaeological, but embraced also cultural geography and a study of the modern population, and it was carried out by a number of teams from different North American institutions with the co-operation of Peruvian

scholars. Each institution supported its own team and is publishing the results, but they worked together and shared certain resources supplied by the Viking Fund of New York. The work was done in 1946, when Prof. G. R. Willey was working for the Bureau of American Ethnology. Although publication has been long delayed, some of Prof. Willey's views have influenced publication by his colleagues, so they have not been altogether hidden from students of the subject. Now that his conclusions are published in full as a Bulletin of the Bureau of American Ethnology*, his work forms an exceedingly valuable and interesting contribution to archaeology.

The work is based on what must have been a very strenuous survey of the visible settlement sites in the valley, and descriptions of them, with plans, form a large part of the book. Each of the descriptive sections begins with a summary of the contents, so that the bulk of them need be used for reference only. They are preceded by introductory chapters which define the problem and describe the valley, and are followed first by a summary with conclusions about the actual settlement patterns, and then by a discussion of what can be learned from them about the population and its organization at different stages. Finally, these data are related to what is known of Peru as a whole. The plates, grouped at the end, are a useful addition, but the reproduction of some of them is a trifle 'woolly'.

Among the several useful publications resulting from the Viru Valley Project, this deserves a prominent place. By his fresh and thoughtful approach to his subject, Prof. Willey has made a notable contribution to our understanding of the ancient peoples of Peru. The organizers of the Project were fortunate in being able to select a unit of manageable size to deal with, and one which was sufficiently self-contained to make it possible to observe the effects of outside influences and invasions. Very useful results might be obtained if it were possible to follow their example in other centres of ancient civilization.

G. H. S. BUSHNELL

* Smithsonian Institution. Bureau of American Ethnology, Bulletin 155: Prehistoric Settlement Patterns in the Viru Valley, Peru. By Gordon R. Willey. Pp. xxii+453+60 plates. (Washington: Govt. Printing Office, 1953.) 4 dollars.

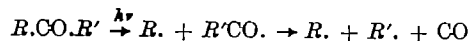
PHOTOLYSIS OF POLY METHYL VINYL KETONE: FORMATION OF BLOCK POLYMERS

By J. E. GUILLET and PROF. R. G. W. NORRISH,
F.R.S.

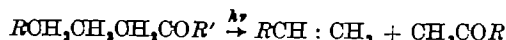
Department of Physical Chemistry, University of Cambridge

THE primary photolysis of aliphatic ketones, both in the gas phase and in solution, has been shown to occur by two simultaneous reactions¹:

Type I, in which two free radicals are formed:



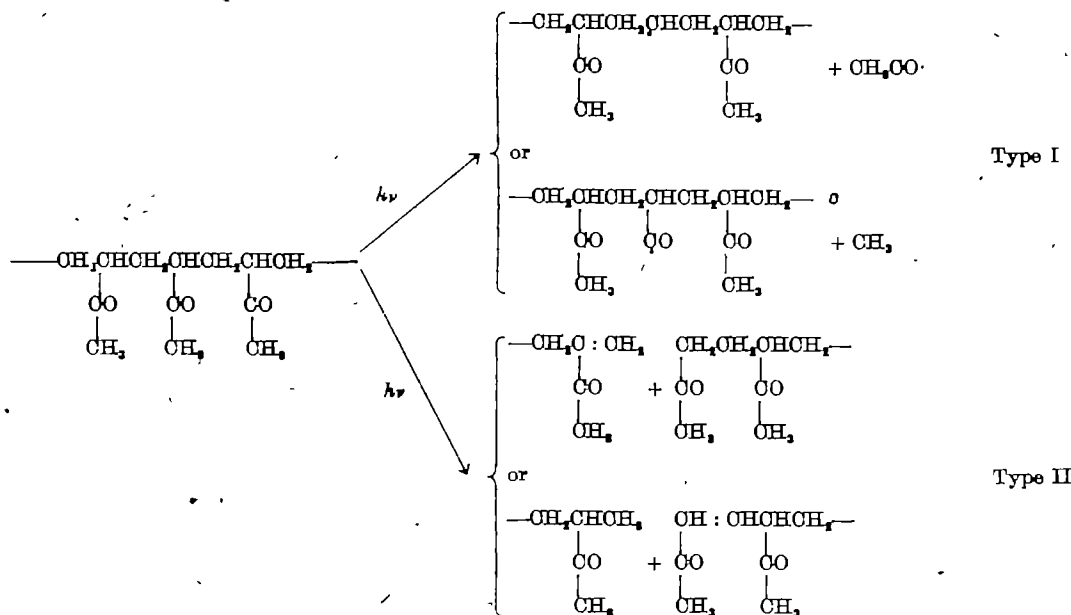
Type II, in which the molecules can split in the α - β position to the carbonyl group to give an olefin and a lower ketone, without the formation of free radicals; for example:



As the temperature is raised from 0° to 100° C., the acetyl radical formed in the first reaction becomes increasingly unstable and decomposes to give a free alkyl radical and carbon monoxide.

The Type I reaction has been used as a source of free radicals for the initiation of vinyl polymerization. For example, acetone has been used as a photosensitizer in the polymerization of a number of vinyl monomers³.

As an extension to this early work, it occurred to us that vinyl polymers containing a carbonyl group would be expected to undergo similar reactions upon irradiation. For example, with poly methyl vinyl ketone, we should expect, schematically:



Both these predictions have been verified. The polymer shows a strong absorption band with its peak at 2900 Å. due to the carbonyl group. Irradiation of solutions in dioxan by light of 3130 Å. caused rapid reaction.

The occurrence of Type I reaction is demonstrated by the formation of carbon monoxide and methane when the reaction is carried out at 80° C., and the fact that aldehyde is formed due to the hydrogenation of the acyl radicals by the solvent.

That Type II reaction occurs as a split in the chain at the bond α - β to the carbonyl group is shown both by a rapid fall of molecular weight, and by the development of the absorption band beginning at 2800 Å., characteristic of the conjugation of the double bond with the ketone carbonyl.

The quantum yield of the Type I reaction is of the order of 0.01, as measured by the rate of formation of carbon monoxide at 80° C., but this must be a lower limit in view of the formation of aldehyde mentioned above.

The occurrence of Type I reaction with poly methyl vinyl ketone, in which free bonds are formed in the polymer chain, immediately suggests the possibility of forming block polymers in which a long chain of one type is grafted to another long chain of a different chemical species.

In order to investigate this possibility, poly methyl vinyl ketone was photolysed in the presence of acrylonitrile monomer. The optical system consisted

of a high-pressure mercury lamp (Siemens Type ME) mounted in front of a large searchlight mirror to give a concentrated beam of light. This was directed on to the reaction cell by two 30-mm. diameter diaphragms 15 cm. apart, using a water-cooled filter composed of 2.0 cm. of a solution containing 180 gm./l. $\text{CoSO}_4 \cdot 7\text{H}_2\text{O}$ and 600 gm./l. $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$, followed by 4 cm. of a solution containing 2.0 gm./l. potassium hydrogen phthalate to isolate the radiation of 3130 Å. Operating at 1,000 watts, this light system gave an energy flux of 1.1×10^{-3} einsteins an hour across an area of 7.0 sq. cm. as determined by a uranyl oxalate actinometer. The reaction cell was of quartz, 2.0 cm. in length and 3.8 cm. in

diameter; it was attached by a side arm to a bulb which could be used for freezing and degassing the solutions, and could be connected to a high-vacuum line through a tap and ground joint. Poly methyl vinyl ketone was prepared by polymerization of the pure monomer in dioxan solution, using benzoyl peroxide as catalyst; it was isolated by precipitation with diethyl ether, and washed with ether to remove any residual catalyst. It was then re-dissolved in dioxan and isolated by freezing with subsequent removal of the solvent by sublimation under vacuum. Osmotic pressure measurements in methyl ethyl ketone solution gave a molecular weight of 220,000. Acrylonitrile was purified by distillation over ferrous sulphate in a stream of nitrogen, and stored until use in a flask cooled with 'dry ice'-acetone mixture; it was then introduced into the reaction cell using a standard volume in the high-vacuum system.

The ultra-violet absorption spectra of the various reagents are shown in Fig. 1. It will be seen that, using monochromatic radiation of 3130 Å., we are working well within the absorption band of poly methyl vinyl ketone, but outside the absorption limit of solvent and acrylonitrile monomer, which latter cannot, therefore, be contributing to any primary chemical reaction. A preliminary series of experiments in dioxan solution showed that the rate of decrease of intrinsic viscosity was measurably less when the degradation was carried out in the presence

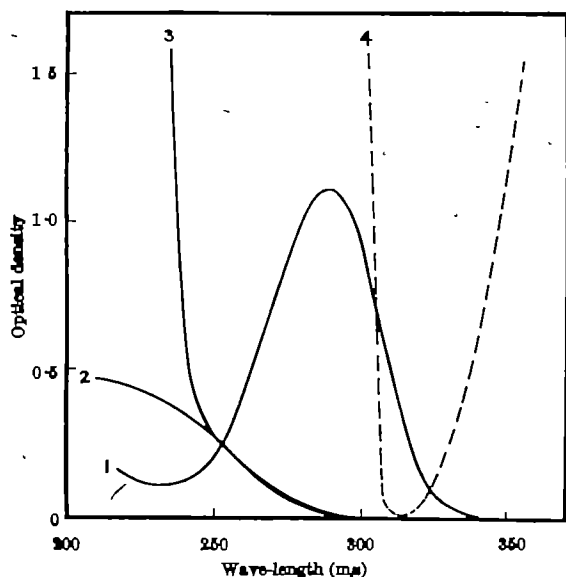


Fig. 1. Ultra-violet absorption spectra. 1, Poly (methyl vinyl ketone), 2.0 g./l. in dioxan; 2, dioxan; 3, acrylonitrile (monomer); 4, filters (combined)

of 4.5 gm./l. acrylonitrile monomer. There was, however, no sign of precipitated polymer even after several hours. If block polymers are formed in this case, it seems probable that the length of the acrylonitrile chains is not sufficient to cause precipitation.

A trial was then made in which 0.200 gm. of poly methyl vinyl ketone was dissolved in 20 ml. pure acrylonitrile monomer. On irradiation there was an immediate appearance of turbidity, and after 4.0 mm. a solid precipitate had formed. This polymer was isolated by freezing, the residual monomer being removed by sublimation under vacuum. A Dumas analysis of the polymer showed it to contain 14.1 per cent nitrogen, which corresponds to 54 per cent acrylonitrile. An identical run in the absence of poly methyl vinyl ketone gave no evidence of polymer formation on irradiation for periods up to 30 min. The intrinsic viscosity of this polymer in dimethyl formamide was 3.8. Using the relationship reported by Houtz⁸ for poly acrylonitrile in this solvent, the molecular weight was calculated to be of the order of 100,000. This corresponds quite well with the molecular weight which would be expected if two poly acrylonitrile chains were formed for each molecule of carbon monoxide formed by the Type I reaction, and allowing for partial depolymerization of poly methyl vinyl ketone by Type II reaction.

The polymer was qualitatively fractionated into three distinct components by the slow addition of dioxan to a 1 per cent solution of the polymer in dimethyl formamide. One fraction, which was precipitated almost immediately, appeared to be largely poly acrylonitrile. A second fraction was obtained which was soluble in mixtures of dioxan and dimethyl formamide containing at least 5 per cent of the latter component but was insoluble in pure dioxan. A third fraction, completely soluble in dioxan, corresponded to the usual degradation product of poly methyl vinyl ketone. It seems likely that the second fraction, which amounts to about a third of the total polymer and contains 75 per cent acrylonitrile, represents the major part of the block polymer formed.

In order to prove that the polymerization of the acrylonitrile monomer was not due to catalyst residues present in the polymer, a sample of pure methyl vinyl ketone was allowed to polymerize at room temperature, in the absence of any catalyst. After several days, about 10 per cent polymerization had taken place. This polymer was isolated by freezing in dioxan in the usual way, and 0.080 gm. was dissolved in 20.0 ml. acrylonitrile monomer and irradiated for 3.0 min. The reaction was immediate, yielding 0.285 gm. of polymer of intrinsic viscosity 4.3 ($M_v = 140,000$). Irradiation of pure acrylonitrile monomer in the absence of poly methyl vinyl ketone gave less than 0.002 gm. polymer. There was no dark reaction at room temperature in either case.

On the basis of these results, it would appear that in the photolysis of poly methyl vinyl ketone free radicals are formed which are capable of initiating the polymerization of acrylonitrile monomer. It seems likely that this leads to the formation of two additional polymeric species—pure poly acrylonitrile initiated by the free methyl radical (or acetyl radical) and a block polymer from the radical formed on the poly methyl vinyl ketone chain.

It is possible that this photochemical method may have further applications in the synthesis of other block polymers.

[Jan. 13.]

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GENETICS OF VIRULENCE IN INFLUENZA VIRUSES

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VIRULENCE of a virus or other pathogenic micro-organism may be defined as the capacity to produce lesions or symptoms in a given tissue or host. It is a quantitative, rather than an all-or-nothing, characteristic, and in practice it can only be assessed in terms of the difference in the response of two or more host animals or tissues which receive the same dose of virus, or of the difference resulting in the same host from the introduction of the same dose of two or more different viruses. The fact that influenza viruses of widely different virulence for the mouse can all be readily grown in the chick embryo and, with some necessary reservations, accurately titrated by haemagglutination, makes viruses of this group particularly well suited for studies of virulence. We have been concerned for some time with an effort to analyse the behaviour of virulence when recombination between different virus strains takes place. In several instances the distribution of virulence among the progeny from a 'cross' between highly virulent and non-virulent strains indicates that there are multiple genetic factors involved. This may provide a new approach to the general problem of virulence in animal viruses.

In all of our work we have used the allantoic cavity of the chick embryo for culture and titration

of strains of influenza virus which possessed characteristic degrees of virulence for some other host or tissue. The earliest experiments were concerned with 'neurotropism'—the capacity of a strain to produce fatal encephalitis on intracerebral inoculation in mice. Subsequent recombination experiments were concerned with strains differing in virulence for the chick embryo as judged by the production of hemorrhagic lesions, or for the mouse lung where the criterion is the extent to which the lung is consolidated seven days after a standard intranasal inoculation. Any influenza A virus isolated from a human infection by chick embryo inoculation and adapted to grow freely in the allantoic cavity lacks all three of these types of virulence. In each case strains of high virulence have had to be obtained by continued passage in the appropriate experimental host. Almost any strain can be adapted to produce gross lung lesions in mice; but only two influenza A viruses have given rise to variants capable of producing hemorrhagic lesions in the chick embryo and/or transmissible fatal encephalitis in mice. These are *WS* (England 1933) and *MEL* (Melbourne 1935).

The general experimental method was to produce double infections with two strains which, in addition to dissimilar virulence, had other 'marker' characters that could be used to differentiate them. The product of these double infections was titrated in chick embryos and then re-titrated to obtain a sufficient number of positive fluids at the limiting infective dilution (*LD* fluids). These were then tested for each of the relevant characters. Representative examples of any recombinant types obtained were re-titrated and a second generation of *LD* fluids tested for uniformity of character.

Neuropathogenicity for the Mouse

In the work carried out by Burnet and Lind¹, and by Burnet and Edney², double infections with the neurotropic strain *NWS* and the standard influenza A strain *MEL* were made in the mouse brain. From these mouse brains, viruses were isolated which were *MEL* serologically but had the capacity to induce fatal encephalitis on intracerebral injection in mice. Such strains had an additional character not found with *MEL* in being convertible to the 'indicator phase' by simple heating at 55°. This character is easily checked *in vitro* by testing whether or not the heated virus is inhibited by high dilutions of a suitable mucoid inhibitor. For convenience all fluids were screened for the two *in vitro* characters, serology and convertibility to indicator, those which conformed to the pattern of neurotropic *MEL* strains being called *NM*'s. It was soon found, as noted by Burnet and Edney², that considerable numbers of *NM* strains were of much lower pathogenicity for the mouse than expected. In Fig. 1 are shown the results of a survey of experimental results obtained during Burnet and Edney's work in 1951. For this it was convenient to use the day of death of a mouse inoculated intracerebrally as an index of virulence. The 34 per cent of 257 mice inoculated with *NM* strains which survived fourteen days includes mice which showed definite symptoms around six days and then recovered completely, and a few—nearly all from groups in which most of the other mice died—which were sick and emaciated at the end of the test period. Others comprising about a-third are from groups in which none of the mice showed any symptoms.

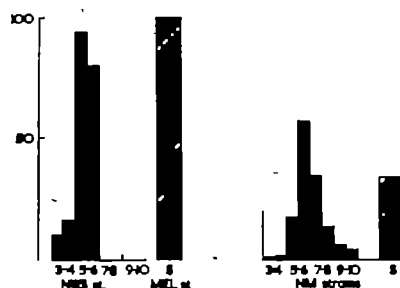


Fig. 1. Distribution of times of death from intracerebral inoculation of a standard dose of influenza virus strains. Area in each shaded bar shows percentage of inoculated mice giving the indicated result. 3, 4, etc., death on day shown after inoculation; S, survived 14 days. *NWS SL* + *MEL SL*, stock viruses by the interaction of which *NM* recombinant strains were obtained.

This has been the general type of experience whenever neuropathogenic strains are produced by recombination. A very similar distribution has been found when interaction of the strains *NM* (actively neuropathogenic) and *WS*—(non-pathogenic) took place in the allantoic cavity. Here the commonest type of progeny to show the *in vitro* qualities typical of the neurotropic recombinant which we refer to as *N-WSE* was only weakly encephalitogenic. Relatively severe symptoms were produced around the fifth to seventh day after inoculation of the standard dose of a fifth of one hemagglutinating unit, but nearly all symptoms had vanished by the fourteenth day. Other fluids of *N-WSE* character *in vitro* produced fatal encephalitis, while some gave no symptoms.

Pathogenicity for the Chick Embryo with Hemorrhagic Lesions

In the course of many experiments with the systems *MEL/WS* and the primary recombinants *M+*/*WS*—²⁻⁴, records were made of the embryo pathogenicity of large numbers of each *in vitro* type. In Fig. 2 the results are depicted in terms of the percentage of inoculated embryos showing lesions of each of four arbitrarily graded levels of severity.

It will be seen that *MEL*, neither as stock nor as experimentally produced recombinant, ever showed any hemorrhagic power; *WS*—showed a very small proportion of embryos with some lesions. Experimentally obtained *WSE* strains show a wider scatter of activity and a lower mean pathogenicity than stock strains. Recombinant *M+* strains show a similar wide range and include a number in the first bracket which represents failure to produce any

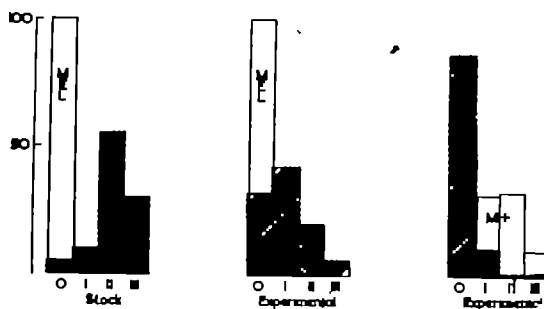


Fig. 2. Distribution of pathogenicity for the chick embryo in original and recombinant strains. Grades 0, I, II, III represent increasing intensity of hemorrhagic lesions in chick embryos inoculated on the chorio-allantois. 'Experimental' fluids are pure clones derived from experiments in which recombination occurred, but include fluids of the same type as the parent forms as well as frank recombinants.

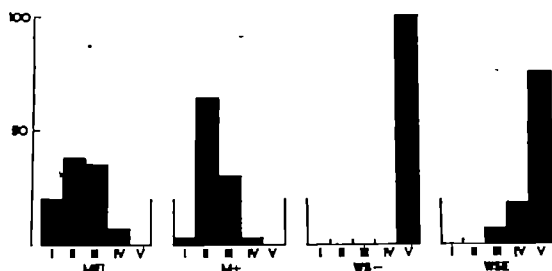


Fig. 3. Distribution of mouse-lung pathogenicity among recombinant types from Influenza A strains. I-IV represent increasing grades of average lung consolidation after administration of a standard dose (1 haemagglutinin unit). The characteristic high virulence of *WS* strains and relatively low and variable virulence of *MEL* strains are unaltered by any of the manipulations.

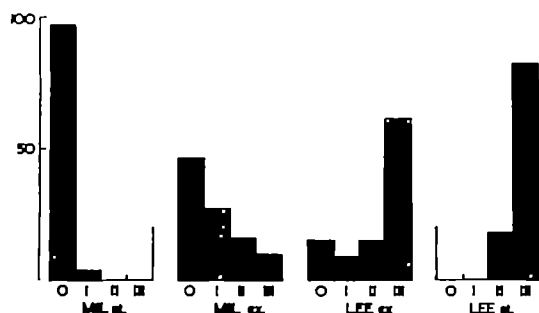


Fig. 4. Distribution of mouse-lung pathogenicity among recombinant types of Influenza B strains. 0-III represent increasing grades of lung consolidation. Distribution of stock virus (st) clones and of clones from recombination experiments (ex) showing the range of pathogenicity associated with each serological type.

haemorrhagic lesions. It should be stated, however, that all *NM* strains which were tested in six or more embryos have produced some haemorrhagic lesions in at least one embryo.

Mouse Lung Pathogenicity

When *MEL* is 'crossed' with the much more pathogenic *WSE*, the recombinants have the same grade of mouse-lung pathogenicity as corresponds to their serological type—*MEL* relatively low and variable, *WS* high and rarely failing to kill all mice inoculated. No differences could be seen between stock and recombinant types, and in Fig. 3 are shown histograms for the four types as obtained from *MEL/WS* or *M+/WS-* experiments²⁻⁴. It is particularly striking that *WS-* recombinants from *MEL/WS* experiments showed none with any reduction of mouse-lung pathogenicity, nor is there any evidence that *M+* strains deviate significantly from the *MEL* pattern.

With experiments on the influenza B strains *LEE* and *MIL*, the pattern of relatively free distribution of virulence among the recombinants is seen again⁵. *MIL* has no lesion-producing power in the standard dose; *LEE* averages 3+ lesions. In Fig. 4 is shown the distribution of mouse-lung pathogenicity for stock *LEE* and *MIL* strains and for all the experimentally studied *LD* strains from a variety of recombination experiments. This shows very clearly the distribution of a wider range of virulence over progeny of both *MIL* and *LEE* types than is ever observed in the stock strains.

Discussion

In most of the examples which have been mentioned, it is clear that the difference between the

highly virulent and the weakly virulent and non-virulent strain is not a function of a single gene. It is in accord, too, with the well-known gradualness with which virulence of a virus for a new host is built up by passage, suggesting that multiple genetic stages have intervened in the process. The development of virulence by a virus has many points of resemblance to the development of resistance to an antibiotic by a bacterium, and it is particularly interesting to find a similar pattern of results from hybridization of *E. coli* *K₁₂* variants, resistant and non-resistant to chloramphenicol⁶. Some of the loci concerned in these experiments could be located in relation to known biochemical markers but others could not. Cavalli and Maocaro interpreted their results as compatible with the occurrence of successive gene mutations, the genes concerned being largely at least non-allelic. Positive and negative interactions between genes were also postulated.

Recent work by Ada⁷ in this laboratory makes it highly probable that influenza virus A does not contain deoxyribose nucleic acid as a necessary part of its structure. If only ribose nucleic acid is involved in the genetic behaviour, it may well be that the mechanisms concerned are a good deal simpler than those typical of mitosis and meiosis in higher organisms. We have developed what appears to be the simplest available hypothesis to account for the results by postulating the existence of 'virulence genes' rather loosely associated with the rest of the genome. Virulence for tissue *x* is determined by the number of the appropriate virulence genes *V_x* associated with each genome. There is a considerable degree of independence in the multiplication of these units in the host cell, and the average number per genome may be modified by a variety of conditions; and in such instances as we have reported here the units may be distributed between two different types of genome. In none of the examples we have studied does this distribution appear to be a random one. If we regard serological type as the identifying mark of a virus and think of other characters in a recombinant as being transferred from the second parent, then we can speak of relative affinities of different genomes for the postulated 'floating' *V* genes. In the *MIL-LEE* system the *V_x* genes contributed by *LEE* are shared with *MIL*, but *LEE* has either a stronger affinity or loses some of its *V_x*'s with so much difficulty that a random distribution is impossible. There is an indication, too, that in the same system it is sometimes easier to lose all *V_x*'s than to hold a sub-standard number (of the undue number of non-virulent *LEE* strains).

In each of the systems we have studied there is an individuality of behaviour. In the *MEL/WS* system there is no evidence of transferability of mouse-lung virulence whatever. The virulence for the chick embryo characteristic of *WSE* is, however, distributed among two of the four genomes produced (*M+* and *WSE*), but not to *MEL* and only to a very slight extent to *WS-*. If a balance-sheet of *V_x*'s could be constructed, one would expect an overall loss as if *MEL* and *WS-* attracted *V_x*'s away from *M+* and *WSE* without being able to incorporate them. Throughout the work we find a tendency in any types of manipulation in the allantoic cavity to show a loss of virulence—often slight—for other types of host cell. The neuropathogenic strains show this well. When a neuro strain is crossed with a non-neuro strain in the allantoic cavity (whether

intact embryo or de-embryonated egg) it is the rule to find a greatly reduced average mouse pathogenicity. With the *NWS/MEL* system it is easy to obtain *in vitro* *NM's*, but these are mostly of very low mouse virulence. To obtain typical neuro-*MEL* strains from this combination in the chick embryo, it is much more convenient to select them from the first-cycle fluid by sub-inoculating this with anti-*WS* serum on the chorio-allantois and re-isolating strains from the embryo lesions. Similar findings were obtained in experiments with the *N-MEL/WS*- and *N-WSM/WSH* systems*.

When a recombinant that has taken up a new virulence is passaged at limiting infective dilution, most of the *LD* fluids show the same grade of virulence; but where there is change, it is far more frequently to a lower grade, and the occasional rise is always slight.

Further work may make it necessary to postulate a more elaborate genetic mechanism for influenza virus, as Visconti and Delbrück (1953)¹⁹ have done for the *T2* bacterial viruses. At the present time, however, it seems better to look for the simplest possible genetic mechanism that will account for the facts. In view of current thought on the nature of bacterial adaptation and recombination, it may become a valuable stimulus to the interpretation of bacterial genetics if analogies can be drawn from a simpler system such as the influenza viruses as well as from the more complex ones of classical genetic theory.

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MORPHOLOGICAL BASIS OF QUALITY IN TEA

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TEA breeding at this Station was begun by us in 1936 on the recommendation of a commission of inquiry led by Prof. (now Sir Frank) Engledow. Much attention has been paid to the production of tea of the quality which is characteristic of Assam and which can be obtained from no other source. For the purpose of breeding, some character indicative of quality is required.

Progress in this direction can be illustrated by quoting Hunter and Leake¹. These authors reviewed the situation in 1933 in the following words: "The problem of tracing quality back to a character or group of characters, inherent in the plant, and sufficiently definite to form the basis of breeding, is hardly capable of solution. Nevertheless efforts in this direction have been made by Gogh (Cohen Stuart, 1930), who found differences in quality

between pluckings of single trees of a magnitude which could be identified by expert tasters".

Early work by the senior author had disclosed an association between hair on the lower epidermis of the fresh leaf and the quality (as distinct from the particles known as 'tip') of the tea afterwards manufactured. This was recorded in 1936². A greater number of parallel observations was required to establish a general case; these have been obtained during recent years.

We have found pubescence of the tea leaf to be genetically conditioned; and plants which are categorized in respect of hair on one occasion can be expected from experience to remain in substantially the same order. It has been observed that a crude classification of plants into five subjective hair groups by momentarily looking at the lower epidermis of the young leaves gives a significant positive correlation with quality. Even when the hair is estimated once only on a single bush in one season at the rate of 500-1,000 bushes a day, and the shoots from the same bushes are manufactured on an average of four occasions in the next season, a significant correlation is obtained ($r = 0.260$. $P < 0.01$). When hair is estimated with proper replicates, the correlation is found to be much closer.

This is illustrated by data in the accompanying table, which were obtained by assigning numerical indices to four subjective hair groups and by assigning numerical indices to a standard set of six degrees of comparison used by the tea taster in his reports. Seven different progenies were studied, each progeny being obtained from a mating between two clones. Six progenies were repeated as two field plots of twenty-four plants each, and one progeny as one plot of twenty-four plants. The block included two comparable plots of plants raised from a commercial source of seed which is generally recognized as possessing high quality. Samples of the plucked shoots from any one plot were spread uniformly over a shallow dish of standard size, and the amount of hair visually estimated under standard conditions of illumination. The dishes were marked by random numbers, the origin of the sample not being known to the observer. The hair was estimated on five occasions in the early part of the season. In the later part of the season shoots plucked from each one of the nineteen plots were manufactured as a separate sample. Each sample was therefore indicative of the overall quality of all the bushes in a progeny, the quality and hair of all but one of the

Progenies	Mean numerical indices for	
	Hair	Quality
A	0.76	10.0
	0.93	25.0
B	0.68	12.0
	0.96	24.0
C	1.26	47.1
	1.07	40.0
D	1.73	43.8
	1.41	35.7
E	1.73	23.5
	1.81	34.2
F	1.79	24.0
	1.88	24.0
G (check from commercial seed)	1.17	41.4
	2.00	47.1
H	2.21	54.8
	2.44	46.1
I	2.59	66.7
	2.96	52.8
J	2.60	56.9

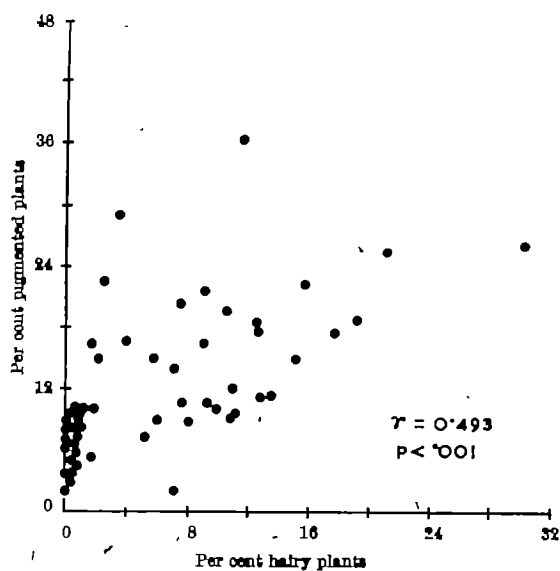


Fig. 1

progenies being determined by two plot repeats. On the first five occasions all the progenies were manufactured, after which the manufacture of the lower quality progenies was successively discontinued to enable other progenies, not relevant to the present argument, to be manufactured; the primary object of the work being to show that progenies considered desirable maintained their quality. The progenies of higher quality and the check were manufactured up to fourteen times from the end of June to early October. The taster received the samples of made tea in tins marked only by random numbers, a different assignment of numbers being used on each occasion. The nineteen pairs of variates obtained from the means of all the observations give a significant coefficient of correlation of 0.76. It is clear that hair can be taken as a reliable index of quality.

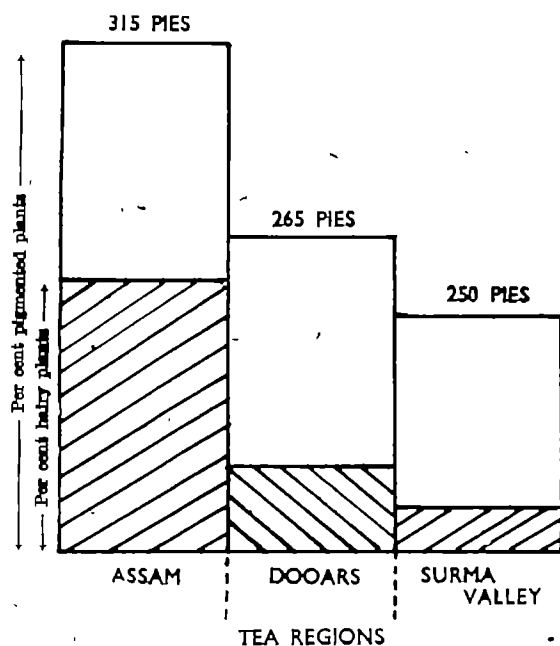


Fig. 2

Occurrence of red anthocyanin pigment in the petiole of the leaf is a genetically conditioned characteristic of a distinct type of tea plant which is probably wild in the valley of the Chindwin. This type is not in itself of value and is not cultivated in Assam. It is glabrous and lacks quality. However, the character petiole pigment must have somehow been introduced into pubescent plants which are generally cultivated and where it is now to be seen with varying but always very low frequency and with an intensity of expression much below maximum. General experience shows that, up to some low optimum, pigmentation of the leaf petiole is beneficial to quality; and above this low optimum, pigmentation is detrimental to quality.

In 1947, members of the Association supplied us with samples of seed from more than sixty commercial sources of supply in the important tea regions of north-east India. The characters of the plants raised from the seed sources of a particular region were assumed to be representative of the kind of tea plant generally cultivated in that region. The information obtained from these plants enabled us to construct Figs. 1 and 2 in which the ordinates are proportional to the separate frequencies of plants with a noticeable amount of pigment and plants with maximum hair. Fig. 1 shows a significant but not invariable association between plants with petiole pigment and plants with hair. In Fig. 2 the data are considered by regions, the numerals giving the average 1948-49 export valuation in pies for the region. There is therefore large-scale evidence in favour of the combination of some petiole pigment with hair in a population of tea plants.

Breeding experience, a description of which would be too lengthy to include in this article, supports these conclusions. If a suitable slightly pigmented plant of low quality be mated to a comparatively non-pigmented plant of good quality, then the tea made from the progeny as a whole, in bulk, is no worse than that of the good quality parent and may be better. The pigment disappears in the offspring to all but the experienced eye at the appropriate season. Vigour can be improved by a mating of this nature; and if the vigour is improved then it may be associated with a uniformity among the offspring greater than is usual among cultivated tea plants. The object of tea breeding is to perpetuate favourable parents vegetatively, so as to obtain a permanent source of F_1 seed.

It is necessary to emphasize that successful use of the breeding operations to which we refer here requires considerable experience. The introduction of petiole pigment in sufficient quantity to be noticed by the untrained eye is likely to reduce quality. Typically, petiole pigment is associated with a dominant glabrous condition. It is therefore necessary to introduce the pigment into an F_1 from the comparatively rare combination of some pigment with sufficient hair. Slightly pigmented plants when bred among themselves may produce undesirable segregates. The morphological criteria require more detailed description than is possible in this article, the object of which is to indicate the progress which has been possible in recent years.

We wish to thank the Director, Tooklai Experimental Station, and the Indian Tea Association for permission to publish these results. [Dec. 4.]

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² Report of the Commission of Enquiry 1935 (Indian Tea Association, Calcutta, 1936).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Thorium Determination in Deep-Sea Sediments

A METHOD for direct measurement of ionium (thorium-230) has been described in a previous communication¹. Ionium was measured in samples of red clay from the Central Pacific Ocean raised by the Swedish Deep-Sea Expedition (1947-48).

The chemical procedure leads to the isolation, together with ionium, of other thorium isotopes: thorium-227 (Rd-Ac), thorium-228 (Rd-Th) and thorium-232, all α -emitters.

The photographic method permits individual measurement of the activity of these various isotopes: ionium and thorium-232 give only single tracks while a fraction of the disintegrations of Rd-Th and Rd-Ac leads to the production of five-branched stars.

This fraction is a known function of the time of exposure in the emulsion²⁻⁴.

If thorium and Rd-Th are in equilibrium, the number of five-branched stars from Rd-Th is a measure of the thorium-232 concentration.

We can measure with the double emulsion technique⁵ as little as 10^{-6} gm. of thorium, provided it is concentrated in a drop of a few microlitres. Care must be taken to prevent the loss of thoron. Experimental details will be published elsewhere.

Rd-Ac also gives five-branched stars and can interfere in the measurements of Rd-Th. In deep-sea sediments, Rd-Ac can originate from two sources: (1) Rd-Ac in equilibrium with uranium-235. If the uranium concentration is known, it is easy to calculate the correction, which in our samples was always less than 5 per cent (values given by Hecht⁶). (2) Rd-Ac produced by protactinium precipitated in excess from the ocean. Although we do not know the concentration of protactinium in sediments, we have certain criteria to control the source of five-branched stars: (a) rate of growth of the star population with increasing time of exposure in the photographic emulsion; (b) decrease of Rd-Ac (half-life, 10 days), while the Rd-Th remains practically constant (half-life, 1.9 years); (c) presence of the characteristic long α -track of thorium C'; (d) rate of decrease of star activity with depth in the sediment (assuming a rate of sedimentation of 1 mm./1,000 years, any protactinium isolated from uranium-235 must be completely disintegrated below 15 cm. from the top of the sediment).

Thorium has been measured in samples of red clay from the Pacific Ocean. The results are grouped in the accompanying table (col. 4). The concentration of thorium has been calculated from the five-branched star production, assuming thorium to be in equilibrium with Rd-Th and ascribing all the five-branched stars to Rd-Th. Absence of appreciable amount of Rd-Ac stars is proved by length measurement of α -tracks of thorium C' on samples 11 and 12 and by the independence of the number of stars of the depth in the sediment.

The number of samples is not yet sufficient to allow any definite conclusion. Still, we can see that the thorium content does not seem to change appreciably from one sample to another. The figures are grouped around the value 5×10^{-4} gm. Th/gm. dried

THORIUM IN RED CLAY FROM CENTRAL PACIFIC OCEAN. CORES OF THE SWEDISH DEEP-SEA EXPEDITION (1947-48)

Sample	Core	Depth in sediment	Th 10^{-4} gm./gm. dry sediment
Blank test (UX ₁ + reagents + photographic emulsion)			<0.08
9	87 B	33 cm.	4.1 $\pm$ 0.4*
3	87 B	47 cm.	3.1 $\pm$ 0.6
4	83	4 cm.	6.0 $\pm$ 0.6
11	86 B	12 cm.	5.6 $\pm$ 0.4
12	86 B	17 cm.	5.4 $\pm$ 0.4
13	86 B	40 cm.	8.5 $\pm$ 3

* Statistical errors only.

red clay. This value is much higher than the figures found by Koczy⁷ in red clay from the Atlantic Ocean. Dr. Koczy has pointed out in a private communication that the difference could be ascribed either to the higher sedimentation-rate prevailing in the Atlantic Ocean, or to incomplete extraction of thorium due to his use of hydrochloric acid extraction instead of dissolution of the samples.

The uranium-content has been measured by Hecht⁸ in other samples from the same cores. He obtains values grouping mostly between 1.5 and 2.5×10^{-4} gm. U/gm. This seems to indicate that in these red clays the thorium-uranium ratio is a little lower, but of the same order of magnitude as the average value in continental rocks.

Chronology of deep-sea sediments by ionium-thorium ratio. Attempts have been made to use the vertical distribution of radium (assumed to be in equilibrium with ionium) for dating back to 350,000 years deep-sea sediments⁹.

This method, which is based on the fact that ionium produced by uranium dissolved in sea-water is precipitated together with the sediments^{1,10,11}, involves some assumptions difficult to check on the rate of precipitation of ionium.

A method based on the ratio ionium-thorium (ratio of two isotopes, one of which is practically stable while the other decays with a half-life of 80,000 years) should be free from this criticism. Such a method would be valid only if: (1) the ionium-thorium ratio in the ocean has remained constant in the time-interval considered (maximum $\sim$ 350,000 years); (2) thorium is precipitated from the sea-water in the same proportion as ionium.

This last hypothesis requires that both ionium and thorium should be dissolved in the same chemical form in sea-water and that all the thorium contained in the sediments should have been chemically precipitated from the sea and not carried in mineral residues.

This hypothesis can be tested by comparing the ionium-thorium ratio in sea-water and in the surface layers of deep-sea sediments or, following a suggestion of H. Pettersson during discussion, by checking if thorium and ionium in the sediments have the same chemical behaviour.

Assuming this condition to be fulfilled, the ionium-thorium ratio in any layer of a sediment column will be found independent of changes, both of the rate of total sedimentation and of the rate of precipitation of thorium and ionium, and should depend only on the time elapsed since the deposition of the layer.

We wish to thank the Oceanographical Institute of Göteborg and the Geological Society of America for financial support. We are indebted to Prof. H. Pettersson and Dr. Koczy for helpful suggestions and to the Misses N. Isaac and G. Poulaert for their

assistance in the chemical separations, and to Prof. G. P. S. Oochialini for useful criticism.

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Electron Energy Distribution in the Striated Hydrogen Discharge

THE distribution of energy among the plasma electrons is a factor of primary importance in determining the processes occurring in a discharge. Two matters of special interest in our work are (a) the processes determining the equilibrium of negative ions in electronegative plasmas, and (b) the mechanism of production of atomic hydrogen in discharges in dry and wet hydrogen. In the first, the case of oxygen is well known to be somewhat anomalous in that the negative ion concentration is very much less than it is in the halogen plasmas, although the electron affinity is not vastly different. In case b, the much greater efficiency of radio-frequency discharges for dissociating H_2 and the fact that increased dissociation resulting from an introduction of water vapour does not seem to be entirely attributable to wall poisoning, suggests that the difference between the energy distribution for electrons in a striated positive column and that in the radio-frequency discharge may be concerned in the changed efficiency. The purpose of this communication is to direct attention to some preliminary results for energy distributions in the positive column of a d.c. discharge in hydrogen.

The method employed makes use of the result of Druyvesteyn¹ that for an isotropic distribution the energy distribution function is given by $f(E) = V^{1/2} \frac{d^2 i}{dV^2}$ where i is the current to a Langmuir probe at a potential V with respect to the space. The quantity $\frac{d^2 i}{dV^2}$ may be determined in various ways, namely, by graphical double differentiation; by making $V \propto t$ (time) and evaluating $\frac{d^2 i}{dt^2}$ using resistance capacity circuits²; by the use of a bridge circuit³; and by noting the change in the mean value of i when V has superimposed upon it a small a.c. component⁴.

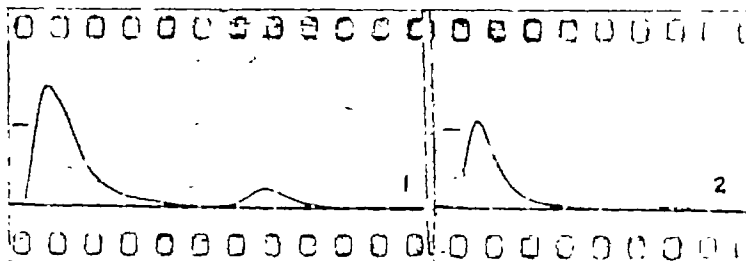
We have used a development of the last method. When a modulated carrier frequency of voltage is superimposed upon the probe potential, then for small carrier amplitudes the component of modulation frequency in the probe current is proportional to $\frac{d^2 i}{dV^2}$. If, by means of a linear potential divider,

V is now made to vary slowly and a square root law potential divider is varied at the same time by direct coupling, then with the aid of suitable tuned amplifier

circuits the product $V^{1/2} \frac{d^2 i}{dV^2}$ may be continuously

presented on an oscillograph. By means of beam switching, the apparatus provides a photographic record of both the energy distribution function and a Langmuir probe characteristic. (The latter is not shown in the accompanying photographs.) At the end of a recording a modulation frequency voltage of known amplitude is applied to the amplifying equipment to enable a scale to be fitted to the energy distribution curve. The energy axis is calibrated by suppressing the oscillograph spot at convenient voltage intervals.

The accompanying figures give some preliminary results obtained in a hot cathode discharge in hydrogen at 0.055 mm. mercury pressure and a tube current of 200 mA. In Fig. 1, the probe is located in the brightest part of the striation. Attention is directed to the presence of a group of electrons having energies considerably greater than the mean. In Fig. 2 the probe is in the middle of the dark space between striations. (In the figures the short horizontal line represents a concentration of 10^6 electrons/c.c./voltage energy range, and the oscillograph spot has been suppressed at 2-volt intervals.)



It is appreciated that the anisotropy of the velocity distribution, particularly in the regions of high field, reduces the precision of the results. An energy spectrometer employing a collimated sample beam and analysis by retardation is under construction. It is hoped to publish further details, both of the experimental methods and of results and conclusions, at a later date.

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Infra-red Spectra of Fluorinated Hydrocarbons

WE have recently examined for analytical purposes the infra-red spectra of some fully fluorinated hydrocarbons. Complex interactions occur in compounds of this type, and it is not to be expected that the absorption frequencies of any particular structural group will be constant: but nevertheless some regularities have been observed which may be useful.

Perfluoro compound	800-850 cm ⁻¹	860-840 cm ⁻¹
1 Decalin	—	860, 845
2 2:7 Dimethyl decalin	745*	853
3 2:9 Dimethyl decalin	738*	850
4 1:6 Dimethyl decalin	744*	848
5 2:6 Dimethyl decalin	738*	850
6 1:3 Dimethyl cyclohexane	733*	859
7 1:6 Dicyclohexyl hexane	632	849
8 1:5 Dicyclohexyl pentane	639	848
9 1:4 Dicyclohexyl butane	676	848
10 1:2 Dicyclohexyl ethane	709	848
11 Dicyclohexyl methane	720	845
12 Dicyclohexyl	738	852

* Denotes compound with CF—CF₂ group

The spectra of simple fluorine-containing compounds have been studied by several workers, and more complex molecules have been examined by Thompson and Temple¹ and by many others²⁻⁷. Some spectra are also included in the American Petroleum Institute (A.P.I.) series. However, in none of the latter cases are any vibrational assignments available.

The compounds examined are listed in the table. They were used as liquid capillary films or as solid mulls in paraffin, and the spectra were obtained with a Perkin-Elmer 21B double-beam automatic recording spectrophotometer with a rock-salt prism.

The most striking feature of the spectra examined is the contrast between the number and intensities of absorption bands in the range 800-850 cm⁻¹ in materials containing the CF₂ group and those in which this group is absent. Compounds containing the CF₂ group show a considerable number of strong absorptions in this region, whereas the unsubstituted cyclic compounds and the open-chain compounds with cyclic end-groups show, at most, a single band. This is true also of the great majority of the published spectra of fluorocarbons. Perfluorocyclopentane, for example, does not absorb in the range 800-850 cm⁻¹, and we find only a weak band at 730 cm⁻¹ in perfluorocyclohexane. The corresponding monochloro derivative, C₆F₁₁Cl, does not absorb in this region. Neither perfluorodecalin nor any of the compounds in the series perfluorodicyclohexyl methane to perfluorodicyclohexyl hexane shows more than a single band in the range 800-850 cm⁻¹.

Closer examination of this region reveals that a band occurs consistently in the range 745-730 cm⁻¹ in the spectra of those compounds which contain the CF—CF₂ or CF₂—CF₂ group. This suggests that some vibration of the CF₂ group, possibly the deformation mode, may be sufficiently stabilized in frequency when it is adjacent to a CF or CF₂ group to give a characteristic absorption. With this possibility in mind, we have examined the spectra of as many fluorinated compounds as we have been able to trace in the literature. Spectra of partially fluorinated aromatic compounds have been ignored, as aromatic ring vibrations can be expected to absorb in the same region; but apart from these we have found that a band in the 745-730 cm⁻¹ region appears in the spectra of 35 out of 48 compounds containing the CF—CF₂ or CF₂—CF₂ group, and that apart from perfluoroethane⁸, which may be expected to be abnormal, all the exceptions contain functional groups in the immediate vicinity of the CF—CF₂ group. Thus, the great majority contain the structure R—CO, R—C= on R—CFCl, in which interactions are only to be expected. In contrast to this, only six of fifty-six fluorinated compounds which did not contain the group showed absorption in the stated region. It appears, therefore, that the CF—CF₂ or CF₂—CF₂

group will give rise to absorption in the 745-730 cm⁻¹ region provided it is sufficiently far removed from the influence of functional groups. This is particularly well illustrated by the spectra of the compounds C₂F₅.COOCH₂CF₃⁹ and C₂H₅.COOCH₂CF₃¹⁰; C₂F₅.COOC₂H₅¹¹ and C₂H₅.COOC₂H₅¹²; and C₂F₅—S—S—C₂F₅¹³ and CF₃—S—S—CF₃¹⁴. The first compound of each of these pairs absorbs strongly at 740 cm⁻¹, whereas the second does not.

Another interesting feature of our spectra is the single absorption band in the range 800-850 cm⁻¹ shown by the series of compounds perfluorodicyclohexyl hexane to perfluorodicyclohexyl. The first member absorbs at 662 cm⁻¹ and the band moves progressively towards higher frequencies with decrease in the number of carbon atoms separating the two rings. Perfluorodecalin shows a similar band at 755 cm⁻¹ and it may be associated with a C—F deformation.

In all the compounds we have examined, and in all the spectra of fully fluorinated cyclic compounds in the A.P.I. series, a band appears in the range 860-840 cm⁻¹. This may be associated with a ring CF₂ vibration since it is usually absent from the spectra of open-chain materials; but it could also arise from the C—C vibrations of the ring.

The perfluorodecalin and the dicyclohexyl compounds also show complex patterns of intense bands in the range 1,350-1,200 cm⁻¹ arising from C—F stretching-modes; but these vary considerably with small structural changes and no regularities can be observed.

Thanks are due to Dr. N. L. J. Megson, of the Royal Aircraft Establishment, Farnborough, for supplying the samples and also to the Chief Scientist, Ministry of Supply, for permission to publish this note.

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Use of Adsorption Columns in the Analysis of Soap and Detergent-stabilized Emulsions

METHODS at present available for the determination of the total materials in aqueous emulsions involve cracking the emulsion, separating the non-aqueous phase by solvent extraction or filtration, and weighing the products prior to analytical investigation. The need for a rapid means of isolating the components of such systems has led to the development of a technique employing adsorbents containing an ion-exchange resin, whereby the separation of an oil-in-water emulsion (for example, wool-scouring liquors) can be achieved. This has been suggested previously¹ as being applicable to large-scale cracking and recovery of emulsified grease from industrial effluents.

In the present work, using columns of 'ZeoKarb 225' ('Permutit') in bead form, mixed with powdered animal charcoal, percolation of soap solutions and emulsions gave clear liquors from which organic matter had been removed. The presence of charcoal diminishes the rate of percolation that occurs with resin alone and increases the extent of adsorption: it is not yet clear whether the charcoal functions purely mechanically or as an additional adsorptive material. Preparation of the columns involves regeneration of the resin and Soxhlet extraction with the solvents to be used for elution. Percolation of the emulsion and subsequent elution with a series of solvents resulted in the isolation of the separate components. With pure soaps, over the concentration-range 0.05-0.4 per cent, elution with ethanol gave a 98-100 per cent recovery of the corresponding fatty acids; with purified, substantially acid-free lanolin, stabilized by pure soaps, ethanol elution gave a 99 per cent yield of fatty acid (calculated on the soap used), and subsequent elution with trichlorethylene gave a 99 per cent yield of lanolin. These two fractions were identified with the pure materials by means of their infra-red absorption spectra, which are characteristic. The fatty acid was also determined by alkali titration.

Under these conditions, therefore, it is possible to obtain an almost theoretical yield of the separate components quite readily. In the case of sodium cetyl sulphate, the pure material was retained on the column, but proved most difficult to remove. Eventually, it was found that elution with ethylene glycol and subsequent titration with aqueous sodium hydroxide indicated a 100 per cent yield of cetyl hydrogen sulphate (identified as cetyl alcohol after hydrolysis with hydrochloric acid). Emulsions stabilized with sodium cetyl sulphate were also estimated, the lanolin being removed from the column by trichlorethylene, and the cetyl hydrogen sulphate afterwards removed and determined as above.

This method has been extended to the analysis of emulsions of a mineral oil (Shell 'Clavus 27') and of a vegetable oil (olive oil), reproducible results being obtained. A more detailed account of the work will be published elsewhere.

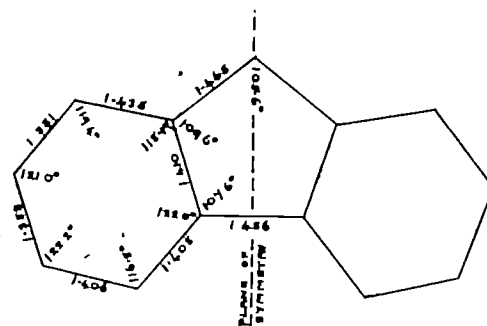
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¹ Shawcross, R., U.S. Patent 2,522,140-1950.

Molecular Structure of Fluorene

THERE has been considerable discussion during the past thirty years or so about the shape and in particular about the planarity of the fluorene molecule. If the molecule is not flat, then there is the possibility of obtaining optical isomers with unsymmetrically substituted fluorene derivatives, and some claims have been put forward that such isomers have been resolved. A qualitative estimation of the main X-ray crystal reflexions from fluorene together with optical and magnetic data led one of us some years ago¹ to the conclusion that the fluorene molecule was non-planar. The consequences in regard to optical isomerism were discussed by Cook and Iball², who gave a brief review of the literature on the subject.



Fluorene ($C_{12}H_8$)

We have now completed a detailed quantitative crystal analysis of this compound, including two-dimensional Fourier syntheses down each of the three axes of the orthorhombic unit cell. Full details of the analysis will be published elsewhere. Here we wish to give the results in regard to the size and shape of the molecule. The accompanying figure gives the bond-lengths (Å) and the bond-angles. The mean bond-length in the benzene ring is 1.403 Å, with a standard deviation of 0.007 Å. The space group is $Pn\bar{3}m$, and therefore, since there are only four molecules per unit cell, the molecule possesses a plane of symmetry which coincides with the (001) plane of the crystal. The carbon atoms all lie on a plane which can be represented in the unit cell by the equation $y = 1.4375x + 11.0947$ (unit cell dimensions are, $a = 8.49 \pm 0.01$; $b = 5.72 \pm 0.01$; $c = 18.97 \pm 0.10$ Å). The maximum deviation of the atoms from this plane is 0.030 Å; root mean square deviation is 0.017 Å. It is clear, therefore, that the molecule is planar, and unless the molecule has a different shape in solution from that which it has in the solid there can be no possibility of optical isomerism.

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¹ *S. Krist.*, **94**, 297 (1936).

² *Chem. and Indust.*, **55**, 467 (1936).

Bashforth-Adams Method for the Numerical Solution of Differential Equations

SEVERAL current text-books on numerical mathematics give descriptions of what is called the 'Bashforth-Adams' process for the solution of differential equations. The method is usually dismissed with a statement to the effect that, since it includes no adequate checking procedure, it is of little use.

Now, although this remark is true of the process envisaged by the authors of the texts, it is not true of the technique developed by Bashforth and Adams, which we can only suppose has been successively retranscribed from some incorrect secondary source by later writers.

To set the matter right, it was thought worth while to publish the following brief note. Page

references are to pages of the original text of Bashforth and Adams¹, and the notation is as given there, except that we have replaced the (Δu_s) of the original authors by the modern (∇u_s) .

In the first place, taking the equation as:

$$\frac{dy}{dt} = f\left(\frac{dy}{dt}, y, t\right) \quad (1)$$

it is pointed out (p. 16) that repeated differentiation of (1) will enable general values of $\frac{d^2y}{dt^2}$, $\frac{d^3y}{dt^3}$, etc., to be found in terms of y and t .

Next, assuming that $y = y_0$, $\frac{dy}{dt} = \left(\frac{dy}{dt}\right)_0$ when $t = t_0$, expansions for y_1 and $\left(\frac{dy}{dt}\right)_1$ at the end of an interval (δt_0) are given as Taylor series:

$$y_1 = y_0 + \left(\frac{dy}{dt}\right)_0 (\delta t_0) + \frac{1}{2!} \left(\frac{d^2y}{dt^2}\right)_0 (\delta t_0)^2 + \dots$$

$$\left(\frac{dy}{dt}\right)_1 = \left(\frac{dy}{dt}\right)_0 + \left(\frac{d^2y}{dt^2}\right)_0 (\delta t_0) + \frac{1}{2!} \left(\frac{d^3y}{dt^3}\right)_0 (\delta t_0)^2 + \dots$$

These are to be used to find initial values of y_n , $\left(\frac{dy}{dt}\right)_n$ ($n = 1, 2$, etc.), to start subsequent interpolatory processes, and some observations on the use and convergence of such Taylor series follow.

From this point the authors address themselves to the solution of the type of equation of principal interest in their own work:

$$\frac{dy}{dt} = f(y, t) \quad (=f, \text{ say}). \quad (2)$$

The backward difference interpolation formula:

$$f_n = f_0 + \frac{n}{1!} \nabla f_0 + \frac{n(n+1)}{2!} \nabla^2 f_0 + \dots$$

is integrated (p. 18) to give:

$$y_0 - y_{-1} = \int_{-1}^0 f_n dn,$$

or

$$y_1 - y_{-1} + (\delta t) \left[f_0 - \frac{1}{2} \nabla f_0 - \frac{1}{12} \nabla^2 f_0 - \frac{1}{24} \nabla^3 f_0 - \frac{19}{720} \nabla^4 f_0 - \frac{3}{160} \nabla^5 f_0 - \dots \right] \quad (3)$$

and

$$y_1 - y_0 = \int_0^1 f_n dn,$$

or

$$y_1 = y_0 + (\delta t) \left[f_0 + \frac{1}{2} \nabla f_0 + \frac{5}{12} \nabla^2 f_0 + \frac{3}{8} \nabla^3 f_0 + \frac{251}{720} \nabla^4 f_0 + \frac{95}{288} \nabla^5 f_0 + \dots \right] \quad (4)$$

It is the second of these formulae which is usually given as the basis of the Bashforth-Adams method, whereas, in fact (p. 19), the authors suggest that (4) be used to predict a value for y_1 and that this value is to be checked and, if necessary, corrected by means of (3), which they rightly point out is of much greater accuracy than (4) for the same number of terms.

The analysis concludes with some formulae for the cyclic refinement of a predicted value when the difference between this and the more accurate version obtained by means of (3) is small enough for squares to be neglected (pp. 19-20).

Tables are also provided (pp. 58-62) to facilitate the calculation of the quantities $\frac{19}{720} \nabla^4$, $\frac{3}{160} \nabla^5$, etc., occurring in (3), and give additional proof that the correction formula was intended for serious use.

It will be clear to the reader that the full method, as described above, is an eminently practical one, and that it differs only very slightly (in the detailed formulae) from the prediction-correction process usually known as Milne's method, which is much favoured at the present time.

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¹ Bashforth, F., and Adams, J. O., "An Attempt to Test the Theories of Capillary Action" (Cambridge, 1883).

Osmotic Pressure of Bull Semen Diluents

BULL semen is usually diluted with egg yolk phosphate¹ or egg yolk citrate buffer² before being used for artificial insemination. The former consists of equal volumes of freshly separated egg yolk and phosphate buffer, pH 7.4 (2 gm. Na₂HPO₄·12H₂O, 0.2 gm. KH₂PO₄ and water to 100 ml.); the latter consists of equal volumes of egg yolk and sodium citrate (2.9-3.9 gm. Na₃C₆H₅O₇·2H₂O and water to 100 ml.; pH adjusted to 6.8 by addition of citric acid, 2.8-10 per cent). Various combinations of bacteriostatic and/or bacteriocidal substances are often added to these semen diluents. The freezing point depressions (Δ) of these diluents, of certain others, and of bull seminal plasma were measured by Ramsay's micro-method³, and the results are given in Table 1. The value given for bull seminal plasma is the mean of forty determinations, using ten bulls of different breeds (Ayrshire, Dexter, Red Poll, Shorthorn and Friesian) over a period of one month. The standard error of $\bar{\Delta}$ (-0.53) is 0.005. Dr. R. Aschaffenburg, of the National Institute for Research in Dairying, Shinfield, has obtained very similar values to those quoted above, using the Hill-Baldeo vapour-pressure technique (personal communication).

Table 1. FREEZING POINT DEPRESSIONS (DEG. C.)

Bull seminal plasma	-0.53
Phosphate buffer + egg yolk (equal vol.)	-0.45
Citrate buffer, 3.92 per cent* + egg yolk (equal vol.)	-0.63
Citrate buffer, 3.4 per cent + egg yolk (equal vol.), containing 0.15 per cent sulphamamide and 250 I.U. streptomycin calcium chloride/ml.	-0.64
Sperm Ringer (Mann, 1946)	-0.53
SGO-2 (Milovanov, 1938)	-0.59
0.9 per cent sodium chloride	-0.54

* w/v here and elsewhere.

The most recent other experiments on this subject are those of Salisbury *et al.*⁴. They found that $\bar{\Delta}$ of bull semen, as distinct from seminal plasma, was -0.587. We found it impossible to measure the freezing point depression of bull semen accurately, using Ramsay's method, because of the opacity of the semen. Apart from this, the freezing point depression of seminal plasma is more meaningful than the freezing point depression of semen, which, in the case of the experiments of Salisbury *et al.*, consisted of seminal plasma containing an unspecified number of dead spermatozoa, the effect of which on such measurements is unknown.

Not much evidence is available on the tolerance of bull spermatozoa to media with different osmotic pressures; but it would seem desirable to use a diluent with about the same osmotic pressure as seminal plasma. In the case of egg yolk citrate buffer containing 0.15 per cent sulphanilamide, this can be achieved by using equal volumes of egg yolk and a 2.875 per cent solution of sodium citrate ($2H_2O$), made up in water containing 0.3 per cent sulphanilamide, brought to pH 6.8 with 5.6 per cent citric acid, also made up in water containing 0.3 per cent sulphanilamide. In the case of egg yolk phosphate buffer containing 0.15 per cent sulphanilamide, a mixture containing equal volumes of egg yolk and phosphate buffer (2 gm. $Na_2HPO_4 \cdot 12H_2O$, 0.2 gm. KH_2PO_4 + 75 ml. water containing 0.3 per cent sulphanilamide) is isotonic with bull seminal plasma. The concentrations in which penicillin and streptomycin are normally added are such as to have only a small effect on the osmotic pressure of the diluent. The freezing point depression of egg yolk itself is -0.58 to -0.60° .

This work is supported by the Medical Research Council; further details will be published in due course.

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Semen Diluents in the Artificial Insemination of Cattle

A NUMBER of studies have been made of the effects of different diluents, with and without the addition of bactericidal or bacteriostatic substances, on the fertilizing capacity of bull semen. Experiments in the United States, where most of the investigations have been made, have been reviewed by Easterbrooks¹, while Rottensten and Oestergaard² have described a series of experiments in Denmark; but no systematic examination of this problem has been made in the United Kingdom, and the American experiments have been on a comparatively small scale, which obviated the possibility of a comprehensive investigation. A large experiment in Britain, involving four Milk Marketing Board artificial insemination centres and their sub-centres, was therefore started in February 1951. The experiment was designed to find out which of the two diluents commonly used in artificial insemination, egg-yolk citrate buffer (equal volumes of 3.2 per cent sodium citrate, pH adjusted to 6.8 with citric acid, and egg-yolk) and egg-yolk phosphate buffer (equal volumes of phosphate buffer, pH 7.4 (2 per cent $Na_2HPO_4 \cdot 12H_2O$ and 0.2 per cent KH_2PO_4 , and egg-yolk), was the better in the sense of being associated with the higher conception-rate, the buffers being used with and without all possible combinations of

sulphanilamide (1.5 mgm./ml.), penicillin (500 units/ml.) and streptomycin (500 µgm./ml.).

The experiment involved the insemination of 68,713 cows with semen from 134 bulls; the split-sample technique was used throughout. A considerable fraction of the computations involved in the analysis of the results was done on EDSAC I, and we are much indebted to Dr. M. V. Wilkes, director of the Mathematical Laboratory, Cambridge, for allowing the electronic calculator to be used for this purpose.

The results show that: (1) egg-yolk phosphate buffer + penicillin improved the conception-rate, as compared with egg-yolk citrate buffer alone, by 9.3 per cent; (2) egg-yolk citrate buffer + sulphanilamide, penicillin and streptomycin improved the conception-rate, as compared with egg-yolk citrate buffer alone, by 6.8 per cent; and (3) egg-yolk phosphate buffer alone was 5.5 per cent better than egg-yolk citrate buffer alone.

The difference between the improvements cited in (1) and (2) is insufficient to justify the adoption of egg-yolk phosphate buffer + penicillin at artificial insemination centres, particularly as egg-yolk citrate buffer has certain advantages, from the point of view of the visibility of the spermatozoa in it, over egg-yolk phosphate buffer. The increase in conception-rate using egg-yolk citrate buffer + sulphanilamide, penicillin and streptomycin is, however, of considerable economic importance.

The details of this work will be published elsewhere.

We are indebted to Sir Ronald A. Fisher for his guidance in the statistical analyses; and also to the members of the Milk Marketing Board's veterinary and technical staffs for their invaluable co-operation in these experiments.

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Artificial Production of Incomplete Influenza Virus

DIFFERENT strains of influenza virus yield different proportions of incomplete particles on heavy infection of the allantois¹; and members of the influenza group can be arranged in a gradient based on this property². The phenomenon itself remains unexplained, as is, indeed, the mechanism of incomplete virus production. In an approach to this problem we searched for other characteristics which would vary in gradient fashion, and hoped to establish a correlation between some better-known viral functions and the change in infectivity.

We have examined the rate of adsorption and elution in the allantois, the 'minimum receptor requirements', the extent to which the strains can inactivate the receptor substance, and the speed with which they are taken up by cells. All these properties showed uneven distribution among the strains, as

will be published in detail elsewhere. However, to date only the rate of viropexis appeared to give the same gradient as that of incomplete virus production, the strain taken up fastest (*LEE*) producing the smallest proportion of incomplete particles. On the strength of this observation the following working hypothesis was formed.

In the period between adsorption to infectible cells and viropexis the particles 'browse' over the surface of the cells², that is, during their two-dimensional thermal movement the viral enzyme groupings will come into contact with specific substrate groups, act on them, and thus reduce the average concentration of substrate over the whole cellular surface. Obviously, the decrease in substrate concentration will be proportionate to the relative number of enzyme units, and to the average time the virus spends outside the cell. It is assumed that a certain amount of intact receptor substance is required for complete virus production, and that below a critical substrate density the cell will produce non-infective particles. The fact that incomplete virus is produced (a) only in the first cycle, (b) only after heavy infective inocula, and (c) to different extents in different strains, is explained by (a) the first cycle being considerably longer than any subsequent cycles³, due mainly to slower viropexis⁴; (b) that effective reduction of overall substrate density can be achieved only by large numbers of virus particles acting for a long time; and (c) that different strains spend different periods on the outer surface of the membrane prior to being taken up. It follows from the foregoing that a treatment which renders the substrate non-attackable or which reduces the lag between adsorption and uptake should prevent the production of incomplete virus; similarly, artificial destruction of the substrate—provided it does not also prevent infection—should result in the production of incomplete particles even in those strains where this would not normally occur, and even after dilute inocula where it is not known to occur with any strain.

The crucial experiment was built around the 'receptor modifying' effect of the metaperiodate-ion⁵. It is known that influenza virus enzymes cannot act on cellular receptors which have been oxidized by appropriate amounts of IO_4^- ; however, such cells are still infectible by the virus. Thus, eggs were given allantoic inocula of 1.0 ml. 0.01 *M* potassium periodate, and an hour later 0.25 ml. 0.1 *M* glycerol to neutralize excess periodate. Following this, 10^4 or 10^6 *ID*₅₀ of fresh *PR8* (*A*) or *LEE* (*B*) virus were inoculated. The fluids, harvested at the height of infectivity (that is, sixteen hours after the concentrated and forty-two hours after the dilute seed), were titrated for infectivity and haemagglutinin content. The results are shown in the accompanying table.

PRODUCTION OF INCOMPLETE VIRUS IN IO_4^- TREATED EGGS

Treatment	Inoculum		Replicates	Yield		
	Strain	Dose		<i>ID</i> /ml.	<i>HA</i> /ml.	<i>ID</i> / <i>HA</i> ± s.d. error
Nil	<i>PR8</i>	10^6	15	7.61	3.35	4.26 ± 0.18*
		10^4	18	9.22	3.31	6.01 ± 0.16
	<i>LEE</i>	10^6	25	9.24	3.12	6.11 ± 0.09
		10^4	17	9.08	2.65	6.17 ± 0.09
KIO_4	<i>PR8</i>	10^6	18	6.43	2.54	3.95 ± 0.10*
		10^4	15	7.73	2.99	4.75 ± 0.12*
	<i>LEE</i>	10^6	16	7.83	3.06	4.78 ± 0.13*
		10^4	17	7.61	3.29	4.31 ± 0.14*

Geometric mean infectivity (*ID*) and haemagglutinin (*HA*) titres are expressed in log₁₀ units.
Significant production of incomplete virus is marked with an asterisk.

The normal ratio of infectivity to haemagglutinin (*ID*/*HA* ratio) is 10^{4-10} . In the absence of pre-treatment with IO_4^- both strains attain this ratio after dilute inocula, and *LEE* even after the concentrated one; thus only large doses of *PR8* lead to the production of 'incomplete' virus particles, with a resultant drop in the *ID*/*HA* ratio. After IO_4^- treatment, on the other hand, all combinations of strains and inocula show ratios significantly lower than the normal, more than 90 per cent of the particles yielded being incomplete. Control experiments have satisfied us that the target of IO_4^- action was the host cell and not the infecting virus.

These results amount to the realization of the second set of predictions, and thus to a positive proof of our hypothesis. The rest of the predictions, which should constitute the indirect proof, are either not amenable to experimental testing—there are at present no means known to render the intact substrate non-attackable—or are well-established empirical facts, namely, the absence of incomplete virus production in later cycles.

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Influence of Nitrate Ion upon the Synergistic Effects of Glucose and *k*-Strophanthoside

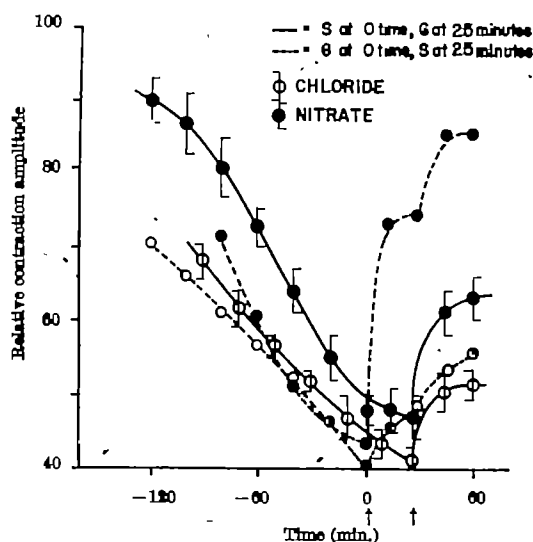
In the present report, we offer evidence to show that glucose is one of the factors limiting the positive inotropic response of the driven ventricle to *k*-strophanthoside (*Strophosid*-Sandoz), and that the magnitude of the reaction to glucose is greater when nitrate rather than chloride is the chief anionic constituent of the nutrient medium.

Electrically driven strips of rats' ventricles were employed as the test objects in the present study. Since the methods of preparing the muscle sections and other details of experimental technique have already been described in previous reports from this laboratory¹⁻³, details of methodology will be omitted from the present communication. All experiments were made in the presence of continuously flowing media that were replenished at the rate of 500 ml./hr. and gassed by a vigorous flow of oxygen through the muscle chamber. The pH of the solutions at 37° C. was 8.3.

The strips were first standardized on 'reference' solution (see table) and then subjected to a low (3.2 mM) calcium glucose-free solution in order to accelerate the 'tiring' process.

COMPOSITION OF STANDARD REFERENCE SOLUTIONS (MILLIMOLES PER LITER)

	Na	K	Ca	Glucose
NO_3^- or Cl^- HCO_3^-	154 7.15	5.63	5.50	5.50



Effect of glucose and *l*-strophanthoside on hypodynamic ventricles. Activity values shown above are expressed relative to the amplitude developed during pre-experimental equilibration on standard reference solution. Negative time identifies the post-standardization fatigue period; S, the addition of *l*-strophanthoside (final concentration 5.73×10^{-4} mM); and G, the administration of glucose (final concentration 5.50 mM). The plotted points in each experimental category are mean values obtained on five ventricle strips and the vertical lines are their respective standard errors.

When the activity of driven ventricle strips that were maintained on the latter solutions had declined to about 50 per cent of the equilibration value, the addition of glucose produced an increase in the contractile response which could be potentiated by the subsequent addition of *l*-strophanthoside. There was no enhancement of the contraction amplitude if *l*-strophanthoside were added in the absence of glucose. The accompanying figure illustrates that the addition of the drug to the medium in a quantity sufficient to yield a 5.73×10^{-4} molar concentration of *l*-strophanthoside (calculated on the assumption that the molecular weight is 872⁴) has no effect until subsequent treatment with glucose.

The influence of inorganic anions upon the response of the substrate-depleted muscle to glucose can be assessed by comparing the two dashed curves in the figure. Within the time restrictions of the test, the response of the fatigued muscles to the addition of glucose was greater in nitrate- than in chloride-Ringer's. Although the subsequent administration of *l*-strophanthoside produced an enhancement of contraction amplitude, the increase was of a lesser magnitude in the case of chloride than of the nitrate series.

Our findings concerning the potentiating effect of nitrates upon the inotropic response to glucose are in general accord with the observations of Sandow⁵, who found that the twitch-tension of the frog's gastrocnemius was augmented in the presence of this anion. Although it is likely that an increase in membrane permeability is concerned in the overall mechanism, its precise role is obscure. On the basis of the present results with glucose it is tempting to ascribe the mechanical enhancement observed in the presence of nitrate ion to the increased flux of sugar into the cell, but the fact cannot be discounted that other substances (for example, K^+) which are known to accompany the inward diffusion of glucose might be more immediately related to the observed effect.

By reference to the figure it can be seen that prior treatment with *l*-strophanthoside decreased the response to glucose of ventricles maintained in nitrate-Ringer's. Owing to the fact that the glycogen content of the muscles surviving in the absence of substrate was low^{6,7}, it can be presumed that the oxidative synthesis of $\sim$ ph was severely reduced; hence any manoeuvre (such as the addition of *l*-strophanthoside or a similar agent⁸) that tends to increase contractile activity by accelerating $\sim$ ph breakdown would be limited in its effectiveness by the amount of oxidizable substrate present. The failure of substrate-depleted ventricles to respond fully to glucose after a 25-min. period of pretreatment with *l*-strophanthoside may be interpreted on the basis that the substrate was entering a muscle which was partially depleted of high-energy phosphate bonds.

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Progesterone Secretion in Ewes

PROGESTERONE secretion during the oestrous cycle of ewes has been measured by means of a chemical assay, with a limit of sensitivity of 0.1 μ gm. per ml. of blood¹. The breeding behaviour of Romney ewes was followed by means of raddled teasers. In fifty-one of these ewes, assays were carried out on blood samples obtained by laparotomy from the ovarian vein draining the active ovary. The results were analysed for an average oestrous cycle of seventeen days, commencing from the day of onset of oestrus.

For the first two days, the amount present was less than 0.1 μ gm. per ml. blood. Detectable amounts were present from the third or fourth day, and increased to about the ninth day. The average quantity remained relatively high until the sixteenth day, with a sudden fall on the seventeenth day. In no case was progesterone detected in blood obtained from the jugular vein at the same time.

There was considerable variation between sheep on the same day of the oestrous cycle. For example, on the eleventh day, the average concentration for six ewes was 1.7, and the range was 0.5–3.4 μ gm. per ml. blood. The quantity of progesterone in the blood of yearling ewes fell within the range of that of three-year old sheep.

Variations as great as those recorded for different sheep may perhaps occur throughout one day in the individual ewe. The absolute amount of progesterone present at any moment may be less important than the daily total, or even than a minimal quantity. A further variable is probably the responsiveness of the target organs. The balance between progesterone and the oestrogens may be the vital factor.

This work is to be continued, and will be more fully reported elsewhere.

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Participation of the Oxidative Pathway in Yeast Respiration

RECENT work has demonstrated the widespread occurrence of enzymes which *in vitro* catalyse reactions in the breakdown of glucose by the so-called hexose monophosphate shunt or oxidative pathway (as distinct from the classical glycolytic route or Embden-Meyerhof-Parnas sequence). Thus the recognition of sedoheptulose phosphate as a labile intermediate and its participation in a cyclic sequence of reactions by which glucose might be completely oxidized¹ has extended the earlier work of Dickens and others and given grounds for supposing that a non-glycolytic breakdown of glucose may occur normally in certain living cells and may, in fact, be a major route of glucose catabolism. The present communication describes results from resting yeast suspensions which are in accord with this supposition.

The method which was used has already been successfully employed by Bloom, Stetten and Stetten to confirm their earlier results from animal tissues which indicated that, in liver slices particularly, the oxidative pathway plays an important part². It is based on the consideration that the mechanism of glucose breakdown will determine the relative rates of release of its constituent carbon atoms into the respired carbon dioxide. Specifically, the carbon dioxide released if the oxidative pathway was operating would be expected to be initially richer in carbon-1 than carbon-6, whereas, if the Embden-Meyerhof-Parnas sequence was the only method of glucose breakdown, carbons-1 and 6 would be expected to appear at equal rates in the respired carbon dioxide.

The yeast (*Saccharomyces cerevisiae*) was grown at 25° C. on a glucose and mineral salts medium. Aliquots of a thin suspension of washed cells in phosphate buffer at pH 5.0, on being transferred to Warburg flasks and shaken at 25° C., showed a negligible endogenous oxygen uptake. When glucose was added, oxygen uptake (with respiratory quotient 1.0-1.2) continued until about 40 per cent of it had

been oxidized; but most of the experiments were terminated when 10-20 per cent of the supplied glucose had been respired. The experimental period was begun by tipping from the side-arms of duplicate flasks either 10 μ M glucose-1-¹⁴C or 10 μ M glucose-6-¹⁴C; the rates of respiration on the two substrates were the same. The carbon dioxide absorbed by potassium hydroxide in the centre well was converted with carbon dioxide carrier into barium carbonate the radioactivity of which was determined with a gas-flow proportional counter^{3,4}. The specific activity of the respired carbon dioxide was determined and the yield of carbon-14 dioxide (in μ mo.) from each of the glucose samples was evaluated. This was then expressed as a percentage of the supplied activity to arrive at the ratio

$$\frac{\% \text{ radiochemical yield from 1-}^{14}\text{C glucose}}{\% \text{ radiochemical yield from 6-}^{14}\text{C glucose}}$$

This ratio has been designated in the tables as ' C_1/C_6 '.

Table 1 shows results from two different yeast samples. It is clear that, whereas the contribution of the C-1 carbon of the glucose to the respired carbon dioxide was relatively large, and its specific activity greater than that of the supplied glucose, that of the C-6 carbon was small. It further appears that, depending on the cultural conditions, the ratio may assume different values. The point we wish to emphasize here, however, is that in none of our experiments have values for the ' C_1/C_6 ' ratio in the early stages of glucose breakdown been close to unity; values ranging from 2.0 to 5.7 have been recorded, and these must be regarded as minimal since earlier sampling, had it been practicable, would have provided even higher values. These results are taken to indicate that the oxidative pathway was playing a considerable part in the respiration of the cells.

In another type of experiment, carbon dioxide samples were collected at intervals from each of two aliquots of yeast, one respiring on glucose-1-¹⁴C and the other on glucose-6-¹⁴C. The results are shown in Table 2. During the first period it will be seen that the contribution of C-1 to the carbon dioxide was 2.5 times that of C-6, but that in the later intervals C-6 appeared in increasing amount while the yield of C-1 was declining, so that the ratio fell to 0.38. At the termination of the experiment, when oxygen uptake had virtually ceased, the total per cent yields from C-1 and C-6 were similar, giving an overall ratio of 1.04 and indicating that no permanent assimilation of C-6 over C-1 had occurred. The changing ratio is in accordance with the suggestion that, at least for some of the glucose molecules respired, carbon-1 is split off at an early stage, as would be expected if they were taking the oxidative pathway, and the fact that C-6 appears in larger quantities later would indicate that the reactions leading to its conversion to carbon dioxide succeed those for C-1 release.

TABLE 1. RECOVERY OF CARBON-14 IN THE RESPIRED CARBON DIOXIDE FROM YEAST CELLS SUPPLIED WITH C-1 OR C-6 LABELLED GLUCOSE

Yeast	Glucose added	Specific activity of glucose (m μ o./mgm.O)	m μ o. added	Specific activity of CO ₂ (m μ o./mgm.O)	m μ o. recovered	Recovered (per cent)	' C_1/C_6 '
12-hr. cells 'aerated' during growth	10 μ M 1- ¹⁴ C	5.40	4.03	5.92	1.24	31.0	2.0
	10 μ M 6- ¹⁴ C	4.71	3.40	2.50	0.52	15.5	
18-hr. cells 'not aerated'	10 μ M 1- ¹⁴ C	18.10	18.40	27.10	2.90	23.5	5.2
	10 μ M 6- ¹⁴ C	4.71	3.40	1.42	0.15	4.8	

Table 2. VARIATIONS IN THE RATIO O_2/O_2^* DURING SUCCESSIVE TIME INTERVALS

	Period I (3 hr.)	Period II (3 hr.)	Period III (5 hr.)	Total
Per cent radiochemical yield from glucose-1- ^{14}C	17.2	13.9	2.2	33.3
Per cent radiochemical yield from glucose-6- ^{14}C	6.8	19.4	5.9	32.1
O_2/O_2^*	2.53	0.72	0.38	1.04

The above methods have been successfully applied in experiments with various higher plant tissues, and here also the results give some basis for discounting the Embden-Meyerhof-Parnas pathway as the sole mechanism of glucose breakdown. A complete report of this work will be published elsewhere.

This research was carried out at the Brookhaven National Laboratory under the auspices of the United States Atomic Energy Commission. We are indebted to Dr. F. G. Sherman, of Brown University, for the yeast culture, and to Dr. B. L. Horecker, of the National Institutes of Health, for stimulating and helpful discussions.

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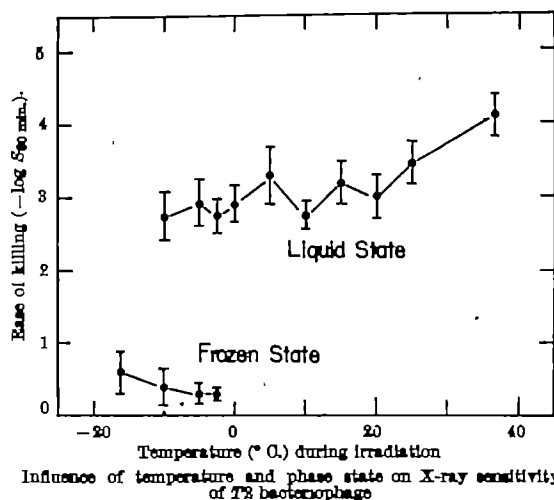
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Dependence of X-ray Sensitivity of Bacteriophage on Phase State and Temperature

SEVERAL studies have shown that biological materials are more resistant to ionizing radiations at extremely low temperatures¹⁻⁴. This is usually explained by assuming that diffusion processes involving 'poisons' produced by radiations (OH, HO_2 , H_2O_2 , etc.) are greatly retarded at low temperatures where there would be negligible free water. The above investigations have not been closely concerned with the region around 0° C. where the liquid-solid phase change would be of importance. The purpose of this report is to describe the influence of temperature (-16° to 37°) and phase state (liquid or solid) on the radiosensitivity of a bacterial virus.

The test organism was T2 bacteriophage, specific for *E. coli*, strain B. Suspensions of 10^4 phage/ml. in buffer (3.5 gm. Na_2HPO_4 , 1.5 gm. KH_2PO_4 , 0.1 gm. $MgSO_4$, 1,000 ml. water) were irradiated in thin glass vials kept in a constant-temperature bath and were diluted afterwards for plating; control and irradiated phage were assayed by standard methods⁵. 250-kV. X-rays at an exposure-rate of 425 r./min. were used for all irradiations. Surviving fractions were computed from controls subjected to the same temperature treatment as irradiated samples. Suspensions kept in the frozen state at the lowest temperatures (-16° and -10°) showed about 50 per cent viability to temperature treatment alone; all other tem-



peratures were not harmful as measured by titre. Phage suspensions as described above normally freeze at -0.5° C.; however, it is possible to supercool these to as low as -10° C. without great difficulty. Thus it is possible to compare radiosensitivities of test organisms that are suspended at the same temperature during irradiation in a liquid medium (supercooled) and in a solid medium (frozen).

T2 irradiated in liquid buffer displayed survival curves similar to those described by Watson⁶, the general shape (concave downward) being fairly independent of the temperature during irradiation. At higher temperatures (above 20°) the radiosensitivity is somewhat increased as previously reported by Alper⁷ for S13 bacteriophage. However, phages irradiated in frozen buffer were much more resistant to X-irradiation and the survival curves themselves were exponential. The radiosensitivity (negative logarithm of the surviving fraction of phage after sixty minutes irradiation) as a function of temperature and phase state is shown in the accompanying figure.

Different phage samples irradiated at -10° in (1) solid buffer, (2) liquid broth (5 per cent Difco nutrient broth), and (3) frozen broth, were all equally resistant to X-rays. It has been suggested that the decreased radiosensitivity in liquid broth is due to the elimination of indirect effects by certain 'protective chemicals' of the broth. Since the magnitudes of the protection afforded by liquid broth, solid buffer, and solid broth are the same, it is probable that all three methods eliminate indirect effects. Broth presumably acts by competing for radiation poisons; the solid phase probably protects by hindering the diffusion of these poisons through the supporting medium to the phage particles. It is interesting to note that Bonét-Maury has observed a discontinuity in the amount of hydrogen peroxide production by X-rays at the phase change point, approximately twice as much hydrogen peroxide being produced in the liquid phase as in the solid phase⁸. This, however, is not to be interpreted as meaning that hydrogen peroxide is necessarily the effective poison in the present study.

The residual radiosensitivity observed even when various protective agents are used is probably due to direct inactivation^{9,10}. Adams and Pollard⁹ found no significant difference between radiosensitivity for T1 bacteriophage in broth and in the dried state. They consider that all inactivation in the dried state

is due to direct effects and hence conclude that indirect effects in broth are relatively small.

This phase state phenomenon with supercooled suspensions offers a new parameter that is being used in connexion with other modifying agents to study the mechanism of cell damage by radiations.

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A Technique for combining the Staining of Fixed Nuclear Material with the Subsequent Separation of Plant Tissue Into Individual Cells

FOLLOWING an earlier investigation¹, a further study has been made of the mode of action of isopropyl-phenylcarbamate. In order that the observed inhibitory effects on the elongation of *Zea mays* roots could be interpreted in terms of cell division and cell extension, it was necessary to evolve a technique which coupled staining of the nuclear material with the separation of root tips into the individual component cells. The method, developed by Brown² for *Pisum sativum*, of gently bombarding carmine-stained root tips with glass beads, failed with maize roots to give adequate cell separation unless the period of bombardment was greatly prolonged, and then too many of the cells were damaged; also the differential staining of the nucleus and cytoplasm was not good enough to allow of the detection of the earliest stages of prophase. The alternative of using a pectinase³ was then investigated, and eventually the following procedure for the separation of previously stained tissue was found to give excellent results if 'Pectinase' (Nutritional Biochemicals Company, Ohio) was employed.

The roots were first fixed in a mixture of 3 parts absolute alcohol and 1 part glacial acetic acid and stained by the Feulgen technique⁴. After washing in distilled water, the excised root tips were placed in a small volume (for example, 0.5 ml. for ten root tips 1 mm. long) of 2 per cent 'Pectinase' made up in distilled water, adjusted to pH 6.6 and saturated with toluol to minimize contamination by micro-organisms. The segments were left in the dark in the 'Pectinase' solution for 12 hr., and at the end of this period most of the 'Pectinase' was removed by a pipette and replaced by an equal volume of 3 per cent solution of a commercial pectin product ('Certo'). By repeated sucking and blowing the tips through a pipette with a fine orifice, the required state of division could be achieved; in order to prevent

a loss of cells due to their sticking to the inside of the pipette a very slow intake was followed by vigorous ejection. When a drop of such a suspension was examined under high magnification ($\times 1,500$), it was found that the cells were either completely separated or grouped into small masses of 2, 4, 8, 16 or, very rarely, 32 cells. There was no sign of damage to the individual cells, and all mitotic stages including early prophase were easily recognizable.

Since 'Pectinase' has also been found effective for the separation of fixed cells in both mature root tissue of maize and the meristems of *Vicia faba*, it is likely that this technique of combined staining and cell separation will be generally applicable.

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¹ Ivons, G. W., and Blackman, G. H., "Selective Toxicity and Antibiotics" (Camb. Univ. Press, 1949). Blackman, G. H., *J. Rep. Bot.*, **2**, 1 (1952).

² Brown, B., *J. Rep. Bot.*, **2**, 96 (1951).

³ Brown, B., *Nature*, **168**, 941 (1951). Chayen, J., *Nature*, **170**, 1070 (1952).

⁴ Daxington, O. D., and LaCour, L. F., "The Handling of Chromosomes" (London, 1947).

Histological Demonstration of Alkaline Phosphatase and Non-specific Esterase by Azo-dye Methods

HISTOCHEMICAL methods^{1,2} already described are capable of greater sensitivity with reduced artefact formation when employed in a manner similar to that recently reported for the demonstration of acid phosphatase³. Increased sensitivity results from enhanced enzyme activity at an incubation temperature of 37° C., demonstration of weak foci of activity in tissues being greatly facilitated. Artefacts resulting from diffusion of enzymically liberated alpha-naphthol is avoided by increasing the speed of azo-coupling and by restriction where necessary of the rate of substrate hydrolysis. Hydrolysis is retarded preferably by reduction of the substrate concentration; this has the advantage over refrigeration of the incubation medium that fast azo-coupling is not prejudiced. For both the usual substrates, sodium alpha-naphthyl phosphate and alpha-naphthyl acetate, the most useful concentrations are 0.01–0.1 mgm./ml.

Accelerated azo-coupling results from incubation at 37° C. and from a high concentration of diazonium salt. Tetrazotized dianisidine (fast blue B), one of the most satisfactory compounds available, is best used at a concentration of 0.2–0.4 mgm./ml.; the high incubation temperature does not greatly increase its rate of breakdown or the concomitant tissue background staining. For tissues showing low residual enzyme activity the concentration of diazonium salt should be reduced to avoid excessive enzyme inhibition; otherwise, in the interests of fast azo-coupling the highest tolerated concentration is desirable.

Evidence of accelerated azo-coupling due to the catalytic effect of the quinoline derivative 'Percain' (2-butoxy-N-(2-diethylaminoethyl) cinchoninamide hydrochloride) is afforded by absence of the off-black shades of dye previously shown to be formed at a slow rate of coupling⁴. A further effect of 'Percain', present in the substrate medium at up to 0.4 per cent concentration, is considerably minimized tissue

background staining, apparently due to slowing of the rate of decomposition of the diazonium compound. The low solubility of 'Perocain' in alkaline media limits its usefulness in the method for alkaline phosphatase unless a low non-optimal pH can be employed; in the method for non-specific esterase (pH 7.5) its effects are particularly marked and in neither instance does it inhibit enzymic activity unduly.

This report is based on studies made while in receipt of a grant from the Auckland, N.Z., Division of the British Empire Cancer Campaign Society.

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¹ Gomori, G., *J. Lab. Clin. Med.*, **37**, 525 (1951).

² Gomori, G., *J. Lab. Clin. Med.*, **35**, 802 (1950).

³ Burton, J. F., *J. Histochem. and Cytochem.* (in the press).

Spiral Development of Mycelium In *Aspergillus niger* Colonies

DURING a recent study of a large number of strains of *Aspergillus niger* we observed a morphological feature not hitherto recorded, so far as we know, for the *A. niger* group. The mycelium growing from a point-inoculation of one strain on a modified Czapek solution agar (normal Czapek solution salts, but 30 per cent sucrose instead of 3 per cent) showed a left-handed twist, or spiral development, when viewed from above in the ordinary way. The word 'spiral' is used loosely, for a form which indeed suggests the picture of a spiral nebula. The tracks both of the primary hyphae and of their lateral branches curved in a counter-clockwise sense as they advanced.

This led us to examine more closely the early development of many other strains, in order to discover whether spiral development is a general feature of *A. niger* and whether right-handed or clockwise spirals also occur. Only a very few cases of pronounced left-handed spirals were found. One such is shown in Fig. 1; the strain is *A. niger* 289, isolated from sunflower seeds; it has an orange-coloured reverse and is a poor citric acid producer. In a few strains the left-handed tendency was just detectable, but the great majority showed no spiral habit at all. One instance of well-marked right-handed spiral development was found. The mould concerned

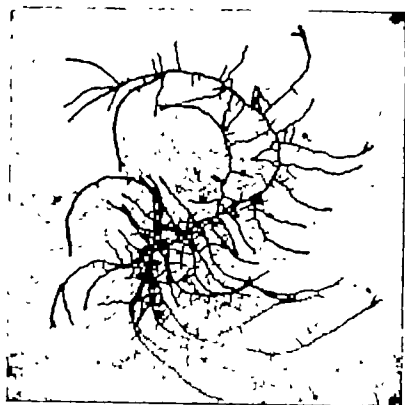


Fig. 1. Left-handed spiral development of colony of *A. niger* 289, 2 days old at 25° C.

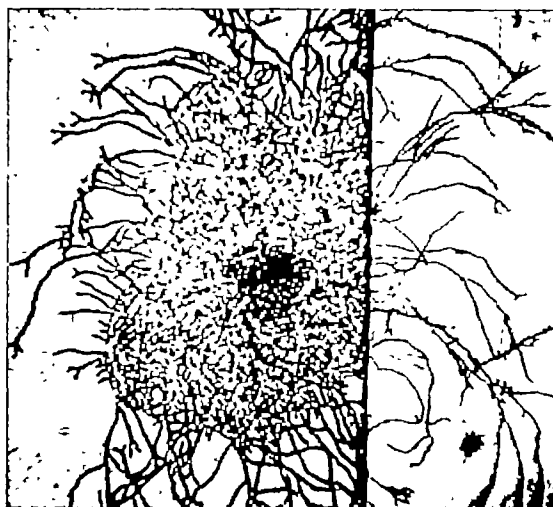


Fig. 2. Young mycelium of *A. japonicus* growing as counter-clockwise spiral on 'Cellophane' overlying agar medium (left), but becoming clockwise after reaching the uncovered medium (right).

proved to be a strain of *A. japonicus*, a species of the *A. niger* group characterized in part by having only one series of sterigmata.

Spiral colonies develop whether the cultures are incubated in the dark or in the light, and twist in the same sense relative to the agar surface whether the plates are kept upside-down or the right way up. In case the nature of the agar surface might be a factor determining spiral development, a disk of agar medium, separated from its dish, was inoculated on the surface which had been in contact with the glass. No change in the spiral character of the resulting colony was detected. On the other hand, *A. japonicus*, inoculated at a point near the edge of a square of 'Cellophane' lying on agar medium, showed left-handed spiral development while on the 'Cellophane', but became right-handed again after reaching the edge and spreading on to the agar (Fig. 2). The question as to how the interposition of a 'Cellophane' membrane can bring about this striking reversal remains to be explored.

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Status of *Szechuanopithecus* from the Pleistocene of China

DESCRIBING a typical Pleistocene fauna (with *Ailuropoda* and *Topirus angustus*) from Koloshan, near Chungking, Szechuan, Central China, Young and Liu¹ have recently figured an isolated lower bilophodont tooth, which according to these authors should indicate a new genus of the *Ceroopithecidae*. As fossil Primates are of special interest to everybody concerned with the study of human evolution, I wish to comment on this matter.

The tooth in question is very small—7.2 mm. long and 4.0 mm. wide at its anterior part. It is regarded by the authors as a third molar "with a very much reduced talonid".

A glance at the text-figure, however, reveals that, while the specimen without doubt belongs to a *Cercopithecus*, it cannot be regarded as a last permanent molar, both on account of the general pattern and also because of the divergent roots. There is little doubt that it is a first deciduous molar (d_1) of normal type, which from the lack of comparative material—the authors mainly refer to Elliot's monograph—could not be recognized by the authors. This tooth certainly belongs to *Macacus robustus* Young, described from the same locality.

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¹ Young and Lau, *Bull. Geol. Soc. of China*, 30, p. 53, Fig. 5 (1951).

Experiments on the Cause of Dorsiventrality in Leaves

Sussex¹ has reported that in apices of potato shoots the presumptive area of I_1 , the next leaf due to arise, develops into a centric leaf, having the shape of a narrow cone, if isolated from the rest of the stem apex by a vertical cut. Such structures are what we previously called radial leaves*. He concludes that the normal dorsiventrality of the leaves is induced by the stem apex. On the other hand, in *Lupinus albus* we found that the presumptive areas of I_1 and of I_2 , the next younger leaf again, when similarly isolated, gave rise only to fully dorsiventral leaves with leaflets*. We have therefore now isolated by vertical cuts in several potato apices the presumptive area of I_1 , or of I_2 ; but these areas gave rise only to dorsiventral leaves, except in one apex which was seen to be suffering from loss of turgor some hours after the operation. In this apex the isolated I_1 area gave rise to a radial leaf. In a further series of operations on potato apices we made the isolating cuts deep and inserted thin pieces of mica, to keep them open and to prevent substances from diffusing across them. The pieces of mica were left in position for some days, by which time the isolated leaf could usually be seen to have arisen. After about a fortnight the apices were pickled and sectioned, and the cuts were found to be still open. Even in these apices all the isolated presumptive areas which developed further, eight I_1 and two I_2 areas, gave rise to dorsiventral leaves, though one of the leaves, an I_1 , was partly tubular. Many of these leaves had indeed looked conical at first when seen in the solid, but when examined in sections later they were seen to be fully dorsiventral, though their blades were often curved inwards towards the stem. These results are quite different from those reported by Sussex, and do not indicate that in potatoes the dorsiventrality of the leaves is induced by the stem apex.

However, in *Epilobium hirsutum*, which forms radial leaves very readily, we have obtained results similar to those reported by Sussex for potato shoots; for the isolated I_1 areas developed only into radial leaves. Yet it is very doubtful whether this indicates that dorsiventrality is induced by the stem apex even in *Epilobium hirsutum*. For in this species, though not in others, we have also obtained radial leaves from the central part of the presumptive area of I_1 and from the central part of P_1 , the youngest actual

leaf, when these regions were not isolated from the stem apex, but were confined at their sides between two vertical cuts which left them continuous with the stem apex towards the centre. In these experiments the stem apex continued to grow and to form leaves, though its growth was sometimes weakened.

At present, therefore, it seems probable that radial leaves can develop in *Epilobium* from some small part of the apical cone of the stem or from the central part of the youngest actual leaf, when such a part, from causes still not clear, grows up from a base which is not large enough to give rise to a dorsiventral leaf. Even a regenerated apex in *Epilobium* may be converted into a typical radial leaf of limited growth if it is extremely small. Also in our potato apices a few small radial leaves developed from small unoccupied areas of tissue that were left over somewhere between the isolated I_1 leaves and the stem. An effect of reduced size of the isolated areas may perhaps account for the radial leaves reported in potatoes by Sussex, though his isolated pieces do not seem from his drawings and description to have been smaller than most of ours. They do seem, however, to have been too close to P_1 for the correct angular position, which may have made a difference. It needs to be further considered whether in *Epilobium hirsutum* reduced size or perhaps weakened growth of the isolated I_1 areas accounts for the radial leaves which developed from them. We hope to publish a fuller account and discussion of our experiments elsewhere.

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¹ Sussex, I. M., *Nature*, 170, 755 (1952).

* Snow, M., and Snow, R., *Phil. Trans. Roy. Soc., B*, 231, 1 (1931) 226, 55 (1935).

Degrading Illite and Potash Fixation

SOME clays from Ireland have been examined by X-ray diffraction, and for these soils and some others a relation between potash fixation and clay mineralogy has been established. The clay minerals detected were illite (as defined by Brown¹), vermiculite, chlorite, kaolin and a material which will be provisionally called 'degrading illite'. Some of the soils contained four of these minerals, others only three.

All the minerals except 'degrading illite' are well established*. Diffraction patterns of air-dry clay containing 'degrading illite' show a band from 10 Å. to higher spacings which generally merges with the background at 12–13 Å. and never extends beyond 14 Å. On treating the clay with glycerol, the band disappears giving either (a) lines at 10 Å. and 14 Å. or (b) a line at 14 Å. It has not yet been possible to decide finally between (a) and (b) as the mineral always occurs with illite, which gives a line at 10 Å. Heating the clay to 350° C. for 12 hr. also causes the band to disappear and the intensity of the 10-Å. line is enhanced.

The soils which had been shown by field experiments to fix potash all contained 'degrading illite' while the others did not. None of the other clay minerals showed this simple relationship. It is there-

fore suggested that either 'degrading illite' fixes potash or is related to the actual cause of fixation.

A more detailed account will appear shortly.

I wish to thank Mr. Pierce Ryan, Soil Laboratory, Johnstown Castle, Wexford, for the samples and information about the soils and field experiments.

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¹ Brown, G., "X-Ray Identification and Crystal Structures of Clay Minerals", Chap. V, Pt. 2 (Mineralogical Society, London, 1951).

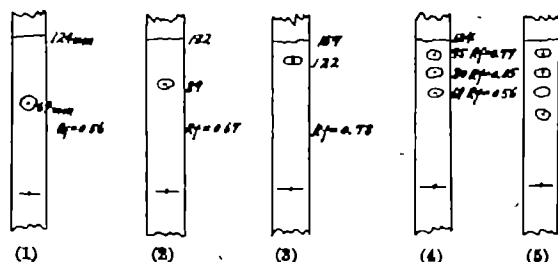
² Brindley, G. W., et al., "X-Ray Identification and Crystal Structures of Clay Minerals" (Mineralogical Society, London, 1951).

Paper Chromatographic Separation of the Isomeric Pyridinecarboxylic Acids

In the course of study on the synthesis of the hydrazide of isonicotinic acid, starting with '5^o-picoline', I realized the desirability of providing a control method to follow the separation of the isomeric pyridinecarboxylic acids. Paper chromatography using *n*-butanol-methanol, a system suggested by the very different solubilities of the acids in methanol and water, has been shown to be very efficient for the separation of the three isomers. The substances used in this experiment were the α -, β - and γ -pyridinecarboxylic acids, a mixture of all three, and the mixture obtained by oxidation of '5^o-picoline' with potassium permanganate. The solvent used for the development of the substances, as shown in the accompanying figure, was *n*-butanol-methanol containing 35 per cent water by volume at 20° C. The paper used was T6y8 qualitative filter paper No. 3, 2/40 cm., and the usual ascending method was carried out in a thermostat (18°-20° C.).

After the development, the solvent on the paper strips was evaporated at room temperature, and the yellow well-defined spots were revealed on blue background by spraying with bromocresol purple solution (0.2 per cent in *n*-butanol saturated with water). Uni-dimensional chromatograms obtained in these experiments are shown in the figure. It should be stressed that the R_F values of the isomeric pyridinecarboxylic acids have excellent reproducibility under the experimental conditions described above. However, in the case of the developed mixture of the α -, β - and γ -acids, the R_F value of each isomer is slightly lower.

The R_F values of the isomers decrease in the following order: $\beta > \gamma > \alpha$. It may be noted that this is the same sequence as that observed for the dissociation constants¹ of the acids, as determined in aqueous solution.



(1) α -Pyridinecarboxylic acid; (2) γ -pyridinecarboxylic acid; (3) β -pyridinecarboxylic acid; (4) mixture of α -, β -, γ -pyridinecarboxylic acid; (5) oxidative product of '5^o-picoline' with potassium permanganate

I am very grateful to Prof. N. J. Leonard for advice, and I wish to express my gratitude to Mr. M. Wayaku, director of chemical research, Osaka Gas Co., for supplying '5^o-picoline', α -picoline and 2,6-lutidine.

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¹ Ostwald, W., *Z. Phys. Chem.*, **3**, 595 (1899).

Paper Chromatography for the Separation of Neutral 17-Ketosteroids in Urine

NEUTRAL 17-ketosteroids have been isolated from extracts of urine by methods too elaborate for routine application^{1,2}. Using chromatography on columns of alumina or silica, quicker methods have been devised³⁻⁷; but these are still somewhat tedious. Separations have been achieved by chromatography on paper previously impregnated with the stationary phase^{8,9}. A technique is here reported for separating the 17-ketosteroids by paper chromatography without any previous impregnation.

The urinary extracts were prepared by the acid hydrolysis of urine followed by extraction with benzene. The benzene extract was washed once with *N* sodium hydroxide, once with distilled water and then dried over anhydrous sodium sulphate. The extract was then shaken with pellets of anhydrous sodium hydroxide⁹ to remove most of the pigment remaining, because it was found that much pigment caused streaking of the chromatograms. Finally, the extract was evaporated to dryness and the residue taken up in a small volume of benzene.

The chromatographic tanks and the solvents used were kept at $34.8^\circ \pm 0.5^\circ \text{C}$. in a thermostatically controlled cabinet provided with an efficient fan. For satisfactory results the atmosphere in the tanks must be in equilibrium with the solvent phases, and the precautions described by Bush¹⁰ were observed. The solvent phases were prepared at 34.8°C . A cyclohexane:20 per cent (v/v) methanol system was used. The Whatman No. 31 paper employed was washed in the mobile phase and dried before use. The extract of urine was applied as spots of approximately 0.5 cm. diameter along a line 14 cm. from one end of a paper strip 40 cm. $\times$ 12 cm. For satisfactory results it was found that the amount of 17-ketosteroid in each spot must not exceed 400 μgm . The paper was equilibrated overnight in the tanks and then run for two hours by the descending technique. The strip was dried, sprayed with a freshly prepared mixture of equal volumes of 14 per cent (w/v) alcoholic potassium hydroxide and 2 per cent (w/v) alcoholic meta-dinitrobenzene, and heated in a stream of warm air for ten minutes.

By this technique six ketosteroid fractions can be detected in extracts of normal male urine. Three of the spots have not yet been identified (approximate R_F values: 0.02, 0.4 and 0.8). One spot (R_F approximately 0.07) appears to be 11-hydroxy-aetiocholan-3 α -ol-17-one and another may be 11-oxy-aetiocholan-3 α -ol-17-one. The most mobile spot (R_F approximately 0.98) is a mixture of aetiocholan-3 α -ol-17-one,

androsterone and perhaps 38-chloro-androst-5-en-17-one. Work is in progress on the further identification of the fractions and the application of the technique to clinical problems.

I would like to acknowledge the financial aid of the Board of Governors of the United Sheffield Hospitals from their Endowment Fund, and to thank Prof. E. J. Wayne and Dr. Arthur Jordan for advice and encouragement.

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- ¹ Dobriner, K., Lieberman, S., and Rhoads, C. P., *J. Biol. Chem.*, **172**, 241 (1948).
- ² Dobriner, K., Lieberman, S., Rhoads, C. P., Hill, B. R., and Fieser, L. F., *J. Biol. Chem.*, **172**, 253 (1948).
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- ⁶ Zygmuntowicz, A. S., Wood, M., Christo, R., and Talbot, N. B., *J. Clin. Endocrinol.*, **11**, 578 (1951).
- ⁷ Rubin, B. L., Dorfman, R. I., and Pinous, G., *J. Biol. Chem.*, **208**, 622 (1953).
- ⁸ Axelrod, L. R., *J. Biol. Chem.*, **205**, 173 (1953).
- ⁹ Dreker, I. S., Helmer, A., Baum, G. R., Stern, S., Pearson, S., and McGavack, J. H., *J. Endocrinol.*, **12**, 55 (1952).
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Quantitative Evaluation of Paper Chromatograms by Infra-red Absorption

THE amounts of materials adsorbed on paper chromatograms can often be estimated directly from measurements of the optical densities of the spots produced by colour-forming reagents. In some cases, it is possible to avoid the colour-forming reaction by measuring the ultra-violet or visible absorptions of the materials themselves. Bellamy¹ has shown that it is possible to examine directly the infra-red spectra of materials adsorbed on paper chromatograms, and it has now been found possible to make quantitative measurements on paper chromatograms by scanning the paper with infra-red radiation of suitable wave-lengths. This method may prove to be particularly useful for substances which do not absorb in the ultra-violet or visible regions and which do not undergo quantitative colour-forming reactions.

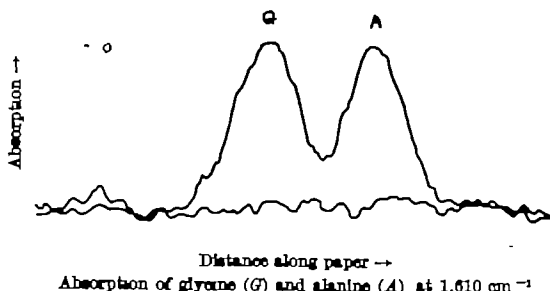
In general, the infra-red method is not as sensitive as the ultra-violet method, since the molar extinction coefficients of infra-red bands are usually several hundred times less than those of ultra-violet absorption bands. Irregularities in the paper are more readily observed when scanning with infra-red radiation, and since all papers appear to transmit radiation more uniformly when cut along one direction, it is necessary first to compare paper strips cut both along and across the machine direction. The need to reduce reflexion by wetting with 'Nujol' limits the most useful range for infra-red scanning to about 2,500–1,500 cm^{-1} . Whatman No. 50 papers appear to be most satisfactory for this work.

Preliminary experiments have been carried out with paper chromatograms of amino-acids which have been developed in 50 per cent aqueous ethanol as solvent. Although other solvent systems would give better separations on the paper, this solvent was selected since it could be removed easily from the paper by warming.

A slightly enlarged image of a Nernst filament was projected on to a paper strip 30 mm. wide. The central portion of the illuminated area, 25 mm. $\times$ 3 mm., was re-imaged on to the monochromator entrance slit of a Grubb Parsons S8 single-beam infra-red spectrometer, the paper strip being drawn across the filament image at a uniform rate of 1 in. per minute. An instrumental slit-width of 0.5 mm. was used, corresponding to a spectral slit-width of 25 cm^{-1} at the 1,610 cm^{-1} amino-acid absorption band.

In order to obtain a higher loading and greater sensitivity, the 5.6- μl . samples of the amino-acid solutions were banded uniformly across the paper strips. After developing the chromatograms for several hours, drying off the solvent and wetting with 'Nujol', the strips were scanned in the apparatus.

It has been found that, in the case of bands which have been developed for approximately the same time interval, a smooth curve related the optical density maximum to the weight of material on the paper. Estimations could be made from this curve with an accuracy of about ± 10 per cent. This non-linear relationship is most probably due to the inhomogeneity of the absorbing medium² and to the diffusion of the bands during the development of the chromatogram. Although the latter effect could theoretically be allowed for by measuring the complete area under the optical density curve, background irregularities would make such a method tedious and not very accurate. A much closer approach to a straight-line relationship has been obtained by plotting the weight of material against the product of the optical density maximum and the band-width at half-optical density. Using triplicate samples, it was found possible to make estimations to ± 5 per cent by this method.



Absorption of glycine (G) and alanine (A) at 1,610 cm^{-1}

The upper line in the accompanying figure shows the recording made from a chromatogram of 560 μgm . glycine and 560 μgm . alanine, after development for 15 hr. The lower line represents the transmission of the same paper strip after the 'Nujol' had been washed off with chloroform, the amino-acids washed out with water and the chromatogram strip again wetted with 'Nujol' after drying.

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¹ Bellamy, L. J., *J. App. Chem.*, **8**, 431 (1953).

² Jones, R. N., *J. Amer. Chem. Soc.*, **74**, 2681 (1952).

FORTHCOMING EVENTS

(Meetings marked with an asterisk are open to the public)

Monday, April 5

SOCIETY OF ENGINEERS (in the Apartments of the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. A. A. Wells: "Brittle Fracture in Steel Structures, with special reference to Liberty Ships".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.45 p.m.—Prof. Sir Geoffrey Jefferson, F.R.S.: "Thinking and Talking" (President's Address).

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Helge Larsen: "Alaskan Eskimo Past and Present".

Monday, April 5—Wednesday, April 7

INSTITUTE OF CHEMICAL ENGINEERS (at The University, Birmingham)—Symposium on "Gas Absorption".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at the Senate House, University of London, Gower Street, London, W.C.1)—Symposium on "Ion Exchange and its Applications".

Monday, April 5—Thursday, April 8

ECONOMIC RESEARCH SOCIETY (at Ashmore Hill, Nr. Leamington Spa), Fourth Annual Conference—"The Scientific Study of Human Work in Industry" (Symposium Secretary: Barbara Murrell, Slaters Cottage, Peppard Common, Henley-on-Thames, Oxon).

Tuesday, April 6

BRITISH OCCUPATIONAL HYGIENE SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Conference on "Maximum Allowable Concentrations of Harmful Materials in Industrial Atmospheres".

INSTITUTE OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Scientific Papers.

SOCIETY FOR ANALYTICAL CHEMISTRY, PHYSICAL METHODS GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Meeting on "Mass Spectrometry".

ROYAL SOCIETY OF MEDICINE, PATHOLOGY SECTION (at 1 Wimpole Street, London, W.1), at 8 p.m.—Symposium on "Immunological Problems on Tissue Grafting".

Tuesday, April 6—Friday, April 9

INSTITUTE OF PHYSICS (at the University, Nottingham)—Conference on "The Physics of Particle Size Analysis".

Wednesday, April 7

ROYAL PHOTOGRAPHIC SOCIETY, SCIENTIFIC AND TECHNICAL GROUP (at the Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 2.30 p.m.—Symposium on "The Applications of Photography to Research at the Imperial College of Science and Technology".

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Wellcome Research Institution, Ruston Road, London, N.W.1), at 8.30 p.m.—Symposium on "The Comparison of Chemical and Biological Estimation of Drugs in Quantitative Pharmacology". Chairman: Prof. J. H. Burn, F.R.S.

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Dr. G. K. Batchelor: "Heat Convection and Buoyancy Effects in Fluids" (Symposium Memorial Lecture).

INSTITUTE OF MECHANICAL ENGINEERS, INTERNAL COMBUSTION ENGINE GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "The Performance of Compression-Ignition Engines under Abnormal Conditions (including Altitude, Temperature, Humidity, Load, Speed or Speed-Variation, Fuel Supply, etc)".

RADAR ASSOCIATION (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 7.30 p.m.—Mr. P. A. L. Harris: "Radar and the Weather".

Wednesday, April 7—Friday, April 9

FARADAY SOCIETY (in the Department of Chemistry, The University, Birmingham)—General Discussion on "The Study of Fast Reactions".

INSTITUTE OF NAVAL ARCHITECTS (on board the Headquarters Ship *Wellington*, Honourable Company of Master Mariners, Victoria Embankment, London, W.C.2), at 10.15 a.m. daily.—Spring Meeting.

Wednesday, April 7—Saturday, April 10

INSTITUTE OF PHYSICS, ELECTRONICS GROUP (in the Cavendish Laboratory, Cambridge)—Conference on "Luminescence" (with particular reference to Solid Inorganic Phosphors).

Thursday, April 8

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 4.30 p.m.—Corporate Meeting; 5.30 p.m.—Dr. W. Ides Jones: First Annual Address.

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Prof. O. G. Sutton, F.R.S.: "The Meteorological Office and the Commonwealth".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 6 p.m.—Annual General Meeting; Sir Ian Heilbron: Research at the Brewing Industry Research Foundation.

SOCIETY OF INSTRUMENT TECHNOLOGY (joint meeting with the CONTROL SECTION, at Mansion House, 26 Portland Place, London, W.1), at 6.30 p.m.—Discussion on "Rationalisation of Units for Electrically Operated Servos".

SOCIETY OF DYERS AND COLOURISTS (at the Midland Hotel, Manchester 2), at 7.30 p.m.—Mr. N. W. Yalland: "Physics in the Dyeing, Printing and Finishing Industries" (Eleventh Mercer Lecture).

Thursday, April 8—Saturday, April 10

SOCIETY FOR GENERAL MICROBIOLOGY (at the Institution of Electrical Engineers, Savoy Place, London, W.C.2)—Annual General Meeting.

Thursday, April 8

Scientific Papers.

Friday, April 9—Saturday, April 10

Symposium on "Autotrophic Micro-organisms".

Friday, April 9

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, University New Buildings, Edinburgh 8), at 11 a.m.—Scientific Papers.

ASSOCIATION OF APPLIED BIOLOGISTS (in the Metallurgy Lecture Theatre, Imperial College, Prince Consort Road, London, S.W.7), at 11 a.m.—Annual General Meeting; 2.30 p.m.—Dr. E. C. Bates-Smith: "Objectives in Food Research".

INSTITUTE OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Paper on "The Control and Observation of Dust at Pneumatic Chassis and Portable Abrasive Wheels". Part 1—Mr. A. T. Holman and Mr. E. B. James: "Dust Control Systems". Part 2—Mr. W. B. Lawrie: "Dust Observations".

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 8.30 p.m.—Dr. M. G. Candau: "The Role of W.H.O. in International Health Work".

Friday, April 9—Saturday, April 10

BOTANICAL SOCIETY OF THE BRITISH ISLES (at Church House, Great Smith Street, Westminster, London, S.W.1), at 10.15 a.m. each day.—Conference: "The Species Concept in its Relation to the British Flora".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT ANALYST (with a university degree or A.R.I.C., and preferably with experience in the analysis of food and drugs)—The County Medical Officer of Health, East Chiff County Offices, Preston, quoting "Assistant Analyst" (April 10).

ASSISTANT COAL SURVEY OFFICER (with a good honours degree or equivalent in chemistry or fuel technology, and preferably with experience in industry, in laboratory control, and in the critical assembly of scientific data) at the Coal Survey Laboratory, Sheffield—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT764 (April 10).

ENGLISH ELECTRIC COMPANY RESEARCH FELLOW (graduate in engineering or applied science, and some experience in aircraft engineering practice) in AERONAUTICS, at the University of Glasgow—The Secretary of the University Court, The University, Glasgow (April 10).

PROFESSOR AND HEAD OF THE DEPARTMENT OF AERODYNAMICS—The Principal, The College of Aeronautics, Cranfield, Bletchley, Bucks (April 13).

SENIOR LECTURER IN MECHANICAL ENGINEERING, LECTURERS (2) IN MECHANICAL OR CIVIL ENGINEERING, A LECTURER IN ELECTRONICS, A LECTURER IN ELECTRICAL ENGINEERING, A LECTURER IN PHYSICS, AND DEMONSTRATORS IN PHYSICS OR MECHANICAL ENGINEERING OR ELECTRONICS, at the Royal Military College of Science, Shrivenham—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S 4807/64 (April 15).

UNIVERSITY PROFESSOR OF PHYSIOLOGY at Patna University, India—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 17).

ASSISTANT LECTURERS (2) IN PSYCHOLOGY—The Registrar, The University, Manchester (April 21).

TURNER AND NEWALL RESEARCH FELLOWSHIP IN ENGINEERING, INORGANIC CHEMISTRY OR PHYSICS or other allied science—The Registrar, The University, Leeds 2 (April 21).

ASSISTANT LECTURER (with an honours degree in mathematics) in MATHEMATICS—The Secretary, Bedford College, Regent's Park, London, N.W.1 (April 23).

ANALYST, Assistant Experimental Officer grade or Experimental Officer grade, in the Insecticides and Fungicides Section at Long Ashton Research Station, for work concerned mainly with the development and application of methods for the determination of insecticide and fungicide deposits on plants—The Secretary, Research Station, Long Ashton, Bristol (April 24).

CHAIR OF PHYSIOLOGY in the University College, Ibadan—The Secretary, Senate Committee for Higher Education in the Colonies, Senate House, London, W.C.1 (April 24).

LECTURER (with a good honours degree in biochemistry, agricultural chemistry or chemistry, and with postgraduate research experience in biochemistry) in AGRICULTURAL BIOCHEMISTRY, A LECTURER IN SURVEYING AND FORMER ENGINEERING in the Department of Forestry, and an ASSISTANT LECTURER (with special qualifications in applied mathematics) in MATHEMATICS—The Secretary and Registrar, University College of North Wales, Bangor (April 26).

LECTURER (with special qualifications in mechanical engineering) in ENGINEERING—The Registrar, The University, Manchester 13 (April 26).

LECTURERS (3) or ASSISTANTS (3) IN GEOLOGY—The Secretary of University Court, The University, Glasgow (April 30).

CHAIR OF CHEMICAL PATHOLOGY tenable at St. Mary's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 3).

LECTURER (Grade II) or ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF THEORETICAL MECHANICS—The Registrar, The University, Bristol (May 7).

LECTURER IN MINING—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (May 8).

READER IN EXPERIMENTAL PHYSICS at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 10).

RESEARCH ASSISTANT IN THE DEPARTMENT OF MINING—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (May 23).

ANGLO-IRANIAN OIL CO. STUDENT (with good degree, and preferably research experience) in the CHEMISTRY DEPARTMENT, for study of kinetics of gaseous reactions—The Registrar, Imperial College of Science and Technology, London, S.W.7 (May 24).

CHAIR OF PURE MATHEMATICS—The Registrar, The University, Birmingham (May 31).

LECTURER (with a university degree, preferably in forestry, and practical experience of forestry in Great Britain or abroad) in FORESTRY—The Secretary, The University, Edinburgh (June 15).

ASSISTANT LECTURER IN GEOGRAPHY—The Secretary, University College, Bristol.

CHEMIST (with an honours degree in chemistry, metallurgy or chemical engineering, or equivalent qualifications) at the Ministry of Supply, Woolwich, to take charge of electro-deposition unit on pilot plant scale—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.170/544.

CHEMIST or BIOCHEMIST (preferably with a knowledge of the chemistry of either fats, proteins or starch, and/or modern laboratory techniques) for fundamental research work—The Director of Research, Baking Industries Research Station, Chorleywood, Herts.

HEAD (with a degree in science or engineering, and some research experience, and preferably with a knowledge of the iron and steel industry) of THE BRITISH IRON AND STEEL RESEARCH ASSOCIATION'S NORTH EAST COAST LABORATORIES at Northumbria, near Middlesbrough, to lead a team of some twenty scientists and technicians operating on problems in connexion with iron-making and iron-making processes—The Personnel Officer, B.I.S.R.A., 11 Park Lane, London, W.1, quoting "Normanby".

LECTURER (with a university degree in agriculture, and preferably with a knowledge of tropical agriculture, and some teaching experience) in AGRICULTURE, at the College of Agriculture, Mauritius—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODH63/52/06.

PHYSICISTS and ENGINEERS (with at least H.S.C. (science) or equivalent) in THE GUIDED WEAPONS DEPARTMENT, Royal Aircraft Establishment, Farnborough, Hants, to assist in development, testing and maintenance of kinetheodolites, special oscillograph cameras, and other associated equipment in target aircraft—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.65/544.

RESEARCH STATISTICIANS (with a good honours degree in mathematics (including statistics), and preferably with research experience in statistics) in the Department of Statistics, for work concerned with the development of statistical theory and its application to agricultural and general biological problems—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

RESEARCH STUDENT (with a good physics degree and some experience of electronics) to work on a special project which will provide opportunity for study for a higher degree—The Professor of Electronics, The University, Southampton.

SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in chemistry, or an equivalent qualification, and at least three years postgraduate research experience, and a knowledge of plastics, paints, adhesives, rubbers and/or surface chemistry) to assist in the control of a chemical development section covering miscellaneous research problems in the organic chemistry field—The Administrative Officer, Recruitment, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 40/W.G.M./2.

Annual Report of the National Oceanographic Council, 1 April 1953–31 March 1953. Pp. v+24+3 plates. (Cambridge: At the University Press, 1954.) 6s. net.

British Commonwealth Scientific Office: North America. The BORS Review of Science in U.S.A. for the year ending June 1953 (United Kingdom Scientific Mission, Canadian Scientific Liaison Office, Australian Scientific Liaison Office, New Zealand Scientific Liaison Office, South African Scientific Liaison Office). Pp. iv+44. (London: H.M. Stationery Office, 1954.) 2s. net.

The Scottish Genealogist. (Quarterly journal of the Scottish Genealogy Society.) No. 1 (January 1954). Pp. 24. (Edinburgh: Scottish Genealogy Society, 1954.) 2s. 6d.

The Year Book of the Royal Society of London, 1954. (No. 58.) Pp. 211. (London: The Royal Society of London, 1954.) 15s. 4d.

Farming to Feed Britain: a Policy for Farm Workers, Farmers and Consumers. Pp. 24. (London: The Communist Party, 1954.) 6d.

M. and B. Laboratory Bulletin. Vol. 1, No. 1 (January 1954). Pp. 12. (Dagenham: May and Baker, Ltd., 1954.)

The Registrar General's Statistical Review of England and Wales for the Five Years 1945-1950. Text (Civil). Pp. vii+244. (London: H.M. Stationery Office, 1954.) 6s. 6d. net.

Communications of the Dublin Institute for Advanced Studies Series A, No. 11: On Relativistically Rigid Surfaces of Revolution. By J. R. Foulds. Pp. vi+53. (Dublin: Dublin Institute for Advanced Studies, 1954.) 3s.

Other Countries

Lady Tata Memorial Trust (International Section). Report on the Research Work on Leukemia and Allied Diseases, assisted on the recommendation of the (European) Scientific Advisory Committee, from the 1st October, 1947 to the 30th September, 1953. Pp. 30. (Bombay: Lady Tata Memorial Trust, 1953.)

Smithsonian Institution: United States National Museum. Bulletin 203: Life Histories of North American Wood Warblers. Order Passeriformes. By Arthur Cleveland Bent. Pp. xi+784+83 plates. (Washington, D.C.: Government Printing Office, 1953.) 4.50 dollars (paper).

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures, and Condition of the Institution for the Year Ended June 30, 1953. Pp. ix+461+43 plates. (Washington, D.C.: Government Printing Office, 1953.) 2.75 dollars.

Fortschritte der Physik. Band 1, Heft 5, 1953: Schwingungsspektren fester Körper. Von G. Lefthoff und W. Brenig. Pp. 187+218. Untersuchung der Ultrarotstrahlung des Naphthalins. Von W. L. Krasnowski. Pp. 219-238. (Berlin: Akademie Verlag, 1953.)

Aportación de la Escuela Española a la Tercera Internacional de Análisis Cromológico y Doctrinal. (Conferencia pronunciada en la Real Academia Nacional de Medicina.) Por el Dr. D. A. García Vicente. Pp. 43. (Madrid: Dr. B. García Vicente, Paseo de la Castellana, 78, 1953.)

International Federation of Culture Collection of Micro-organisms. Annual Report, 1952. Pp. 24. (New York: International Federation of Culture Collections of Micro-organisms, 1953.)

National Institute of Genetics (Japan). Annual Report, 1952 (No. 3). Pp. iii+66. (Mama, Shinjuku-Ken: National Institute of Genetics, 1953.)

The Third Annual Report of the National Science Foundation. Year ending June 30, 1953. Pp. vii+110. (Washington, D.C.: Government Printing Office, 1953.) 40 cents.

U.S. Department of Agriculture. Farmers' Bulletin No. 1624: The Mexican Bean Beetle in the East and Its Control. (Revised edition.) Pp. 16. (Washington, D.C.: Government Printing Office, 1953.) 10 cents.

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 111, No. 1: Revisionary Notes on the Ant Genus *Myrmica* of Australia. By William L. Brown, Jr. Pp. 36. Vol. 111, No. 2: Ticks (Ixodidae) of the Malaya Faunal Region (Excepting the Seychelles): Their Origins and Host-relationships; with descriptions of five new *Hemaphysalis* species. By Harry Hoogstraal. Pp. 87-114. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1953.)

Sudan Government. Ministry of Agriculture-Forests Department. Report for the period July 1951 to June 1952. Pp. iv+70. (Khartoum: Ministry of Agriculture, Forests Department, 1953.)

Forest Department, Kingston, Jamaica. B.W.I. Annual Report for the year ended 31st March, 1953. Pp. 12. (Kingston, Jamaica: Forest Department, 1953.)

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjerd Serien, Band 4, No. 1: Die Diatomeen von Schweden und Finnland Teil 2: Arraphideae, Brachyraphideae. Von Astrid Glöve-Baker. Pp. 168+35 plates. 40 kronor. Fjerd Serien, Band 4, No. 4: Ett Nordbores Krongebiet i Mellan- och Väst-Island. Von B. Lindman. Pp. 7. 2 kronor. (Stockholm: Almqvist and Wikells Boktrycker AB.; London: H. K. Lewis and Co., Ltd., 1953.)

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Council for the Promotion of Field Studies. Annual Report 1952-53. Pp. 83+8 plates. (London: Council for the Promotion of Field Studies, 1954.)

Aluminium Development Association. Research Report No. 21: The Determination of Torsion Constants for Bulbs and Fillets by means of an Electrical Potential Analyser. By P. J. Palmer. Pp. 24. (London: Aluminium Development Association, 1953.) 7s. 6d.

Society for Freedom in Science. Occasional Pamphlet No. 14. Pure and Applied Science and their Appropriate Forms of Organization. By Michael Polanyi. Pp. 13. 1s. 3d. Occasional Pamphlet No. 15: Freedom and Authority in Scientific Publication. By John R. Baker. Pp. 14. 1s. 3d. (Oxford: Society for Freedom in Science, 1953.)

Liverpool Observatory and Tidal Institute. Annual Report, 1953. Pp. 16. (Liverpool: Liverpool Observatory and Tidal Institute, 1954.)

Building Research Station Digest No. 62 (January 1954): Review of Enquiries, 1953. Pp. 4. (London: H.M. Stationery Office, 1954.) 2d. net.

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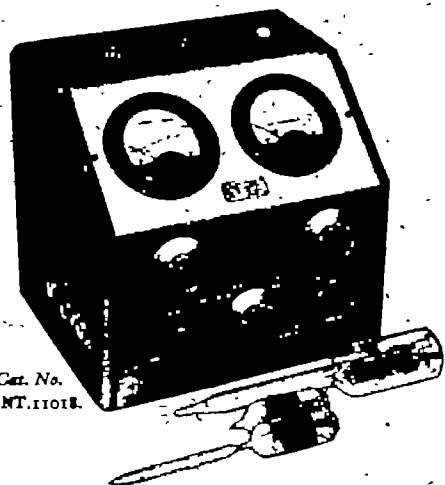
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ATURE

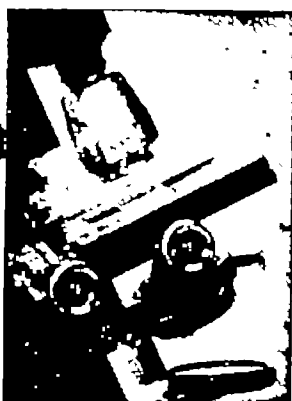
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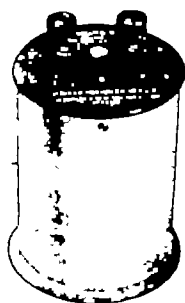
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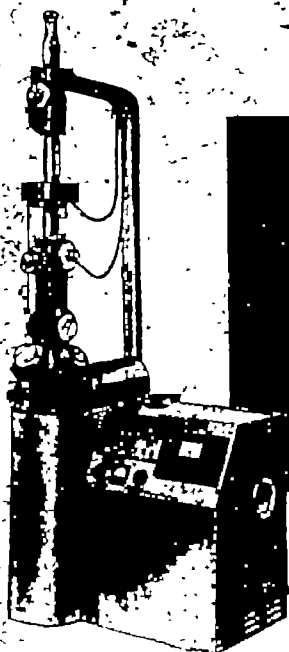
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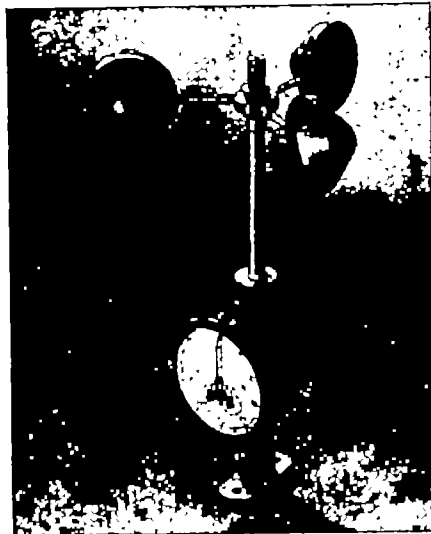
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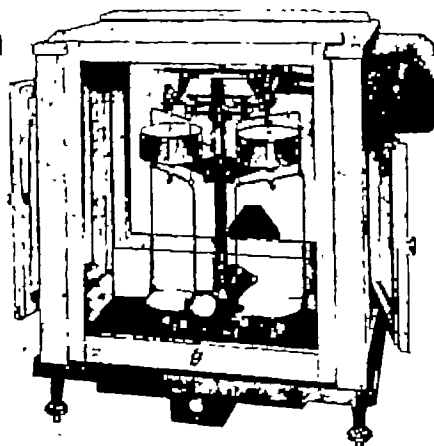
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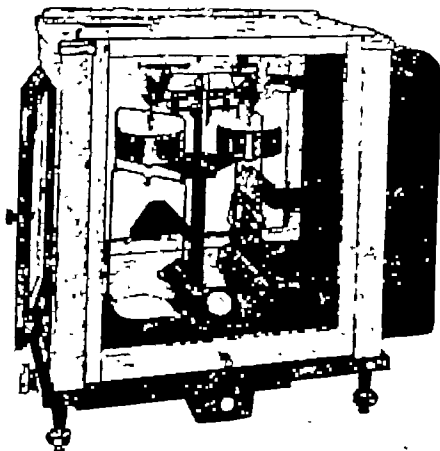


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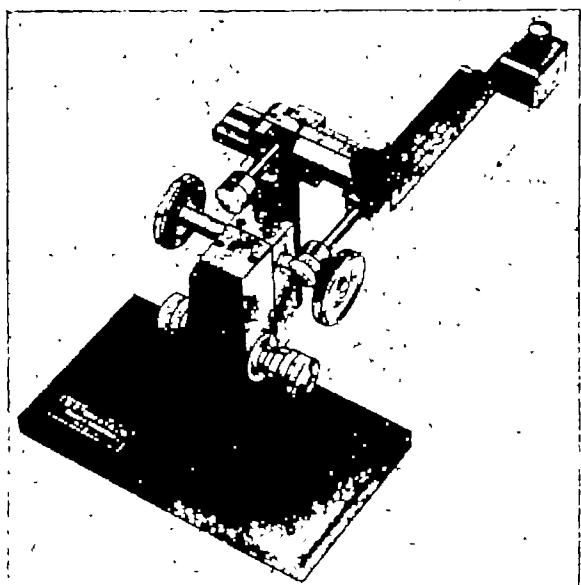


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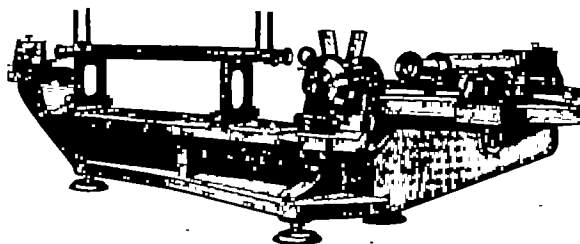
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RESEARCH PLANNING AND POLICY

DR. VANNEVAR BUSH, president of the Carnegie Institution of Washington, as witness his recent annual address to the Institution, and the trustees of the Nuffield Foundation and like bodies are much concerned at the present time with the relations between scientists and administrators in research planning and policy. Some of their problems were examined by Mr. C. V. Kidd in an article in *Science* last year (112, 147; 1953). He directed attention, as Prof. M. Polanyi has done, to the limitations which science itself sets on the freedom of a particular investigator, and he finds a solution to this problem of reconciling initiative and freedom with the direction or planning of research through the recognition that decisions should only be taken at the appropriate level. Those responsible for the decisions regarding the deployment of resources should not attempt to make the decisions regarding the execution or details of particular projects or experiments. Their decisions may and do set limits within which those responsible for the leadership of groups or the carrying out of specific investigations must lay their plans; but particularly in fundamental work, there should be the greatest possible freedom to select work, as well as to choose means, and to deviate from any predetermined plans.

These arguments, from various quarters, afford ample justification for the concern which has been expressed as to the consequences of excessive dependence of American universities upon Federal funds for the support of their research activities. The independent research institution organized on the lines indicated by Dr. Bush and concentrating on finding the outstanding man and giving him his head is not merely well qualified to sponsor investigations in fields neglected by other bodies and where the prospect is too speculative to justify the commitment of public resources; it offers at least as good prospects as anywhere else of securing the general agreement and understanding as to the choice and conduct of particular investigations which provide the appropriate atmosphere for creative work and the guidance and development of individual genius. Such conditions are, of course, equally to be found in the universities, and it is by no means certain that the independent institution enjoys quite as much advantage over the university as Dr. Bush suggests. Freedom from teaching responsibilities may be an illusory advantage unless there is something in the contacts between research workers in different disciplines or branches of science which provides the same stimulus, interchange of ideas and inspiration as the close intercourse of different subjects and inter-education of teachers of one subject by those teaching another which Sir Ernest Barker notes as one of the great advantages of the tutorial system at Oxford.

Dr. J. D. Millett's report for the Commission on Financing Higher Education shows clearly that responsible opinion in the United States fully recognizes both the inevitability of sponsored or contract

research, and also the dangers inherent in such research especially when it is sponsored by the Federal Government; nor is there any attempt to disregard the complexity of the issues involved. Probably the greatest danger is that of balance: both staff and other resources are liable to be deflected into specific lines of inquiry, often of a development type, to the neglect of fundamental research. There is also the question of stability arising from uncertainty as to the duration of support; and other questions may arise such as the academic status of the research staff involved and the secrecy requirements hindering exchange of information or publication of results.

Here the principles laid down by President H. W. Dodds, of Princeton University, in a recent statement published in the *American Scientist* (42, 128; 1954) offer sound guidance; and they are supported by Dr. Millett's comment that much of this development work proceeds at best on a basis of trial and error because the requisite fundamental knowledge is lacking. Indeed, he goes so far as to suggest that at least half the cost of much applied research in the United States to-day could have been avoided if more basic knowledge had been developed in their universities. Government support of research has proved its value; but the problems which it has brought, notably that of duration, has demonstrated that it does not by itself solve the financial problem of fundamental research. It has, in fact, as Dr. Millett points out, enhanced the importance of other sources of income if universities are to maintain their independence and balance.

Fortunately, it is clear from this report that the prospects of independent benefactions, quite apart from the activities of the independent research institutions or foundations, are brighter in the United States than in Britain. It is not considered that this is a negligible and dwindling source of income, and so long as the present dependence of universities upon Federal funds for support of fundamental research exists, it appears to be possible that income from this source may offset any falling off in the volume of research supported through the defence agencies and especially on a contract basis. How far this hope is justified may well appear doubtful to the disinterested observer, in view of the attitude hitherto adopted by Congress to the National Science Foundation. Although, as Dr. Millett reminds us, a very strong argument can be advanced that the security of the United States is best served by a policy of promoting fundamental research in preference to development research, Congress will have to show a marked change in outlook before real confidence can be felt that it is likely to endorse the continuing support of fundamental research at the universities in the natural sciences by appropriations through the Atomic Energy Commission and the defence agencies which at present administer so much of this expenditure.

Apart, moreover, from the questions of balance and of the discretion to be left in the hands of the university administrators rather than government officials, there are important questions of co-operation—

between universities themselves, and between them and the independent research institutions which have hitherto received little attention. It is here that Dr. Millett's analysis of the criticisms of the independent research institutions is valuable. He accepts the view that these institutions—because of their independence—are right to be adventurous, to explore unpopular subjects, to survey fields which government and other agencies shun and to encourage promising talent that has not yet established a reputation. If, however, these bodies are to avoid long-term commitments, and leave to other agencies the task of carrying to completion their successful explorations, there is substance in the frequent criticism of the short-term character of their grants. A measure of co-operation and concerted policy is required at this point, and though it may well in practice come by informal rather than by formal means, neither in the United States nor in Great Britain has the difficulty been entirely resolved.

Probably the inquiries of the National Science Foundation will assist to that end in the United States. In Britain it is obviously engaging the attention of the University Grants Committee, as can be seen from the reference to ear-marked grants in its last report. Neither that body—nor any one formal body—is so constituted as to be able to deal with the problem in all its aspects, though some guidance might well come from the Office of the Lord President of the Council on particular issues. Beyond that it is one to which the Parliamentary and Scientific Committee or the Federation of British Industries could perhaps offer an informal contribution at the appropriate moment, through a joint conference such as those which Nuffield College, for example, arranged some ten years ago on industry and education and on problems of scientific and industrial research.

The second criticism noted by Dr. Millett, that the project approach concentrates attention upon research rather than upon instruction, is scarcely relevant in the present context and in Great Britain. The independent research institution is concerned, by its nature, primarily with the advancement of knowledge, and its contribution to the training of research workers is most effectively made by the continual movement back to the universities or into industry or Government research institutions of young investigators whom it has picked out and trained. The industrial research associations cannot be described as independent research institutions in the sense in which we here understand that term, but it may be noted that part of their proved value to the industries they serve lies in the supply of trained scientists and technologists to these industries, and the educational functions of the research associations are in fact being increasingly stressed. Even the advantages of teaching noted by Sir Ernest Barker would not, however, justify deflecting the work of the research institution from the investigations for which it was established to the task of instruction.

By and large, the research institution's contribution to instruction is made by the continuous process of interchange of workers; and that contribution will be

the more fruitful the more the organization of its projects is such as to avoid the departmentalism which is liable to characterize a university, and to encourage the contact or even conflict of minds across different disciplines which is so fruitful of new ideas. A further criticism, that foundations tend to transfer to their own staffs those functions of the choice of projects for support and the magnitude of the support to be given, has more justification and bears somewhat upon this point. Both points of view will call for constructive thinking in order that frustration and waste of effort and resources may be avoided. President Dodds and Mr. Kidd give indications of the solution, and close and informal contact between the staff of a foundation and the university or research institution such as a reasonable and constant interchange fosters can do much to keep decisions within the appropriate level without encroaching on the competence of others.

It seems clear from these studies that while rather more concern is felt in the United States as to the long-term effects of increasing Federal support of research, the prospects of continuing support from independent voluntary sources are better there than in Great Britain. At least while the present level of taxation persists, it is difficult to give a confident affirmative answer to Lord Beveridge's question whether the succession to the Webbs is secured. Whatever the device with which the society of the future ensures that the spiritual successors to the Webbs have their material resources for research, untrammelled by other duties, by orthodoxy or by prescription of topics, the independent research institutions and the universities will have an essential part to play. That of the Government may well lie less in the direct provision of resources than in seeing that national policy is such that neither fiscal, economic nor any form of political pressure is allowed to discourage initiative, enterprise or the free interchange of minds and exchange of ideas which are the basis of creative activity and the advancement of knowledge in any field.

IN HONOUR OF CHARLES SINGER

Science, Medicine and History

Essays on the Evolution of Scientific Thought and Medical Practice written in honour of Charles Singer. Collected and Edited by E. Ashworth Underwood. Vol. 1: Pp. xxxii+563+50 plates. Vol. 2: Pp. viii+646+56 plates. (London: Oxford University Press, 1953.) 2 volumes £11 11s. net.

CHARLES SINGER, never more learnedly active or intellectually alert than now, in his seventy-eighth year, is a great figure in the history of science, whose influence goes far outside those academic circles to which many of those dedicated to his discipline are restricted. His services in the sphere of learning that he has made his own cannot be set down in a few words, but they comprise outstanding original work in the history of medicine; pioneer exertions as a teacher and as a promoter of the

teaching of the history of science; the writing of general text-books; the production of choice and beautiful books for more specialized readers; and the fostering of international co-operation between scholars devoted to the history of science. The two volumes of "Studies on the History and Method of Science", which he edited and to which he contributed outstanding articles, have become much sought-after rarities. Very fitly he is a doctor of medicine, science and letters, for he is Hippocratic, learned and lettered. He has, in the course of a life characterized by a warm-hearted enthusiasm, an informed curiosity and far travel along both the highroads and byroads of learning, gathered together a great body of friends, all gifted but with diverse gifts, and some time ago one prominent among them, Dr. E. Ashworth Underwood, undertook the organization of a tribute of admiration and affection from these many men. The present two imposing volumes comprise the essays, ninety in number, offered in homage to one who is the founder of a great and world-wide school of historical research. Dr. Underwood set out on his pious and laborious task many years ago, and since the start fifteen of the authors, including such veterans as dear D'Aroy Thompson, have passed away. To bring together and to edit so many contributions, many of them from distant lands, inevitably takes time. The result is impressive. Dr. Singer has the first claim on our congratulations, the contributors a first claim on our thanks, but Dr. Underwood deserves an ample share of both.

It is not easy in a necessarily restricted space to do justice to studies so numerous, all of great merit and many of outstanding interest, by so many authors, all of profound learning and many of international fame, where the selection of some may seem to suggest, quite wrongly, that all the others are less worthy of note. The variety accords well with the range of the Singers' interests—for Dorothea Singer stands by the side of her husband in these celebrations as in erudite and domestic sympathy. The international character indicates the wide-spread scope of their friendship, for, besides many outstanding contributions from the United States, there are offerings from at least seven European nations. The essays are grouped chronologically in seven "Books" or sections, beginning with the ancient world, Egypt, Greece and Rome. This first section includes an unexpected article on "St. Augustine and Magic", by Dr. Claude Jenkins, in which we find already the legend that the presence of diamonds inhibits the attractive virtue of the magnet, a belief accepted so widely and so late that William Gilbert carried out an elaborate experiment to prove that it was baseless. The next section deals with the medieval world, where we have articles of profound scholarship in remote byways of ancient learning, such as that by Dr. H. E. Sigerist on a fifteenth-century manuscript by Johannes Hartlieb, an early German humanist who brought together gynaecological treatises, and that by Chaim Rabin on the writings of Ibn Jami, who was physician to Saladin. Names more familiar figure in Dr. Sherwood Taylor's erudite and entertaining article on the Quincentenary. Book III brings us to the Renaissance, with, corresponding to his importance, three studies on different aspects of Vesalius. Agnes Arber, an old friend to whom Singer dedicated his "Short History of Biology", is, luckily, well represented by a study in a subject in which she is

paramount, "From Medieval Herbalism to the Birth of Modern Botany". In this group, too, we find a delightful example of light-hearted learning in an essay by Prof. F. J. Cole on Dürer's rhinoceros. It was in 1515 that the artist executed his famous drawing and woodcut of the Indian rhinoceros, or "Gomda", as he called the beast. The eminent zoologist traces Dürer's picture—incidentally, he had never seen a rhinoceros, alive or dead, when the drawing was made—through all the copies, adaptations and transformations down to its last appearance in 1769, with a delightful series of reproductions. Another unexpected study illustrating the diversity of the collection is that, in Book V, by Dr. H. J. Norman on John Bulwer, the seventeenth-century author of "Anthropometamorphosis", a treatise on the deformities and decorations of the human body produced in all parts of the world by fashion. It was a work often cited in Victorian attacks on tight-lacing, but is not much heard of nowadays. A drawing by Daumier comes as somewhat of a surprise in scholarly surroundings, but it illustrates appropriately Dr. Paul Delaunay's brilliant little essay, in Book VII, on P. C. A. Louis as the founder of medical, as distinct from vital, statistics.

To return to our ordered survey, the fourth Book, entitled "The New Philosophy", deals with the period of the reaction against Aristotle and with the beginnings of modern science, while the fifth is concerned with the seventeenth century in general. Here Dr. Arnold Sorsby contributes a very informative article on Richard Banister's services to ophthalmology, the importance of which, we believe, he was the first to stress. Incidentally, articles of ophthalmological interest in the whole work range from Dr. Kurt von Fritz on Democritus's theory of vision to Dr. Dorothy Turner on Thomas Young's work concerning the same subject. Attention may be directed to Dr. Max Fish's detailed and fully documented study of the little-known *Investiganti* of Naples, an academy which flourished at the time of the *Cimonto* of Florence and continued to exist until 1737.

The eighteenth century likewise has a Book to itself, in which Dr. Underwood's contribution is one of the most considerable and, so far as I am able to judge, most original studies, dealing as it does with the text-book of physiology, to use modern terms, written in 1701 by Johann Gottfried von Berger, a name not mentioned in Garrison's "History of Medicine" or other well-known histories of the subject. The Book on the nineteenth century and after contains seventeen papers, of which Sir Geoffrey Jefferson's very frank but sympathetic treatment of Marshall Hall's work on reflex action is certainly not the least interesting.

The book concludes with a series of studies of general import contributed by famous names, such as Dr. Redcliffe Salaman, Dr. John Fulton, Prof. C. D. Darlington and Dr. Joseph Needham, as well as, among younger men, Mr. H. T. Pledge. Perhaps it is typical of the quality and scope of the whole collection that whereas the first essay of all is a brilliant survey of the growth of archaeology to its modern position as a science, by Prof. Gordon Childe, the last is a charming collection of reminiscences by Charles Sherrington, whose early hero, Fernal, figures frequently in the essays. This brings to mind a feature of the editing that deserves a special word of commendation, namely, the indexes of persons and subjects, which are particularly full, well

designed and well carried out, and are an invaluable addition to a work of this kind. Thus, if one wants to know what is said of Fernal in different places, one has only to turn to his name to find the various references descriptively set down, not just paged.

Famous names, in themselves a guarantee for the excellence of their contributions, which have not even been mentioned are Dr. George Sarton, founder and editor of *Isis* and *Osis*; Prof. J. R. Partington; Dr. Gavin de Beer; Sir Zachary Cope; Prof. Herbert Dingle; and Dr. Douglas McKie—and there are others. The survey which this notice has been able to offer is slight, the selection of essays for mention arbitrary; all that can be hoped is that the reader will have gathered the impression that here is a book which any lover of learning, especially one with historical and bibliographical tastes, can pick up, open anywhere and read with the greatest pleasure and profit, or, alternatively, of which he can in lazy mood turn the pages, look at the pictures and read odd passages, to be lured to more serious attention. It is an ideal book to take up for after-dinner entertainment, a hard book to put down. Let us conclude with a quotation from D'Arcy Thompson's feeling study entitled "The Golden Age", in which he considers how particular periods have been outstanding in different countries for exceptional achievement in science and art—"But we may turn from the way-side and the market to watch the kindly faces of a little company of unworldly men. They are not (as I see them) the faces of statesmen, nor warriors, nor even artists, authors, poets: they are just the earnest student-faces of far-seeing and deep-thinking men"; and after the citation of great names in science of the period from Faraday to Rutherford and Planck—"Some of these dwell among the Gods, the rest are Heroes. And our children's children will look back on the great century of science to which they belong, and will know it for a Golden Age".

E. N. DA C. ANDRADE

FRESHWATER ECOLOGY

Fundamentals of Limnology

By Dr. Franz Ruttner. Translated by Dr. D. G. Frey and F. E. J. Fry. Pp. xi+242. (Toronto: University of Toronto Press; London: Oxford University Press, 1953.) 52s. net.

THOSE engaged in teaching freshwater biology have for long felt the lack of a satisfactory text-book, and many must have wished Prof. F. Ruttner's "Grundriss der Limnologie" were available in English. This wish has now been answered by two professors, one American, the other Canadian, who both set out independently to translate the book and only heard through a mutual friend in Scotland of each other's intentions. The result was their collaboration in the present volume.

The first half of the book gives a clear and concise account of "Water as an Environment" in two sections covering respectively the "Physical Properties of the Environment" and "Dissolved Substances and their Transformations". The approach is essentially ecological, and the information is presented as the physico-chemical background which is fundamental to an understanding of the biology of fresh waters. The second half is devoted to "Biotic Communities" and is divided into four sections of unequal length covering plankton, and other communities of lakes,

bogs and running water. The longest and most interesting of these is that on plankton. Here the author's point of view is primarily, though not exclusively, chemical; but what is known of the physiology of the organisms is also taken into account in discussing their ecology, and occasional comparisons with the sea are illuminating. If there are aspects of the subject which receive rather scant treatment, this is compensated by the author's stimulating ideas on others. This section really hangs very closely on to the first half of the book.

With the change of subject to "The Other Communities of Lakes" the treatment becomes much less exhaustive, and one is conscious that the author is a little outside his own particular field. But the section on "Communities of the Ooze", where the point of view is again mainly chemical, is as interesting and stimulating as anything in the earlier parts of the book. There is here an admirably lucid exposition of the fundamentals of this intricate and complex system.

The translation is so good that one is only very occasionally reminded that the original was not written in English, and there is a useful list of the words the translators have adopted as equivalents for some of the technical terms of the subject. While some of these seem too obvious to be worth mentioning, one wonders what led them to coin the words 'highmoor' and 'lowmoor' [sic] for *hochmoor* and *flachmoor* instead of using 'raised bog' and 'valley bog', respectively. It may be that limnologists do not use these terms as precisely as plant ecologists; but these do in fact seem to be the senses in which Prof. Ruttner uses them.

But the smallness of these criticisms is an indication of the general excellence of the book, a fact which no limnologist would dispute. Not only does it gather together much of the information scattered in the literature and weave it into a well-knit whole, but it also throws a flood of light on Prof. Ruttner's insight into many of the problems of the subject in a way which none of his previous publications do. The only amendment I would propose to the translators' assessment of it as "perhaps the best book available in any language on the principles of limnology" would be to substitute "undoubtedly" for "perhaps". All British and American workers in the subject will be grateful to Profs. Frey and Fry for making it available in English.

H. C. GILSON

HEALTH AND SICKNESS IN BRITAIN DURING WAR-TIME

The Civilian Health and Medical Services

Edited by Sir Arthur Salusbury MacNalty. Vol. 1: The Ministry of Health Services; Other Civilian Health and Medical Services. (History of the Second World War: United Kingdom Medical Series.) Pp. xi+441. (London: H.M. Stationery Office, 1953.) 45s. net.

"WAR is the enemy of health." Yet wars in our recent history have been a direct stimulus to progress in medical science and the development of health services. This volume tells the remarkable tale how, after a brief set-back in the early days of the Second World War, steady improvement in the public health went on in Great Britain as measured not merely by falling mortality-rates but more

positively by steady advance in the physical development of the nation's children.

No doubt we were lucky in some of our escapes from epidemic diseases, for example, the long-awaited and much-dreaded influenza epidemics which never came. But it was by no means all luck. Intensive planning for the war emergency began at the Ministry of Health two years before the outbreak of war, and the British Medical Association along with the Royal Colleges of Surgeons and of Physicians played their part by preparing, and later carrying out, the mobilization plan for the medical profession.

War gives courage to make long-needed reforms. The Emergency Public Health Laboratory Service was one of the great innovations of the War. Yet Sir John Simon had foreseen the need last century, and his successor at the Local Government Board, Sir Arthur Newsholme, pressed the need for it, in season and out, and would have achieved his object but for the outbreak of the First World War. This Service was introduced in anticipation of great epidemics. These never materialized, but the laboratories were brought into permanent place in our health services by Dr. G. S. Wilson's bacteriologists, who did much to raise national standards of diagnosis. Chlorination of water supplies was introduced against the increased risk to water supplies from air raids and lesser war-time threats, and this, too, became a permanent feature of our public health control. The diphtheria immunization campaign was one of the great achievements of the War; its importance can be measured against the experience of the Channel Islands, which were exposed to the severe Continental epidemic of diphtheria in 1942-43. The Ministry of Health was allowed to introduce by radio frank and realistic discussion on venereal diseases, and public opinion, well ahead of its guardians as often, received this without dismay.

The epidemics of cerebro-spinal fever during the years 1940-42 were sharp and unpleasant, and followed precedents established during the Napoleonic Wars, the American Civil War and the First World War. We were more fortunate than our forbears because of recently developed and effective chemotherapy against this killing disease. Epidemic hepatitis was another traditional war-time disease which gave a good deal of trouble. No specific remedies were available; but a great deal was learnt about the natural history of the disease, and the related scourges—serum jaundice and post-transfusion jaundice, this latter being a bitter by-product of the brilliantly successful war-time blood-transfusion services.

Our fortune with tuberculosis was mixed. In the early days of the War chronic infectious patients returned home from sanatoria beds emptied in anticipation of air-raid casualties. This and war-time conditions brought a rise in the tuberculosis death-rate during 1940-41. Among adults it was older men, not young women, as in the First World War, who fared worst. The most disquieting feature was the increase in deaths among young children from pulmonary tuberculosis and meningitis. Later the tuberculosis death-rates resumed their pre-war downward trends. Notifications, however, continued to rise, partly at any rate due to improved means of diagnosis, and with rising notification-rates came prolonged waiting-lists for admission to sanatoria. The threat from tuberculosis had its valuable achievement in certain innovations, notably the introduction of mass miniature radiography and the system of

tuberculosis allowances to encourage the early diagnosed case to accept treatment.

Undoubtedly the greatest achievement of all was in the field of nutrition. The rationing policy was the result of pre-war research. Long before the War, emergency food policies had been outlined, and at the outbreak of hostilities the new Ministry of Food accepted as the essentials of its policy not only the need to economize in shipping space but also the equitable distribution of food, with special attention to those on whom the future depended—that is, children and expectant and nursing mothers. Apart from rationing, the raising of the extraction-rate of flour, the development of school milk and meals, and the encouragement of factory canteens were important features of policy.

It is an unexplained wonder that the overcrowding in air-raid shelters produced so few ill-effects. After the first crisis and blundering of the 'blitz' were over, devoted efforts were directed to the improvement of sanitation and ventilation in the shelters and to the development of medical services and epidemiological studies. All these things must have helped, but they do not explain the providential escape from disease.

Not least among the effects of the 'blitz' was the introduction to each other, through the evacuation, of Disraeli's two nations. The discovery that head lice, impetigo, ringworm and bed-wetting were common was a surprise only because we had shut our eyes to these things in peace-time. In coping with these problems, the School Medical Service played a major part, and it should not be forgotten that the Education Act of 1944, passed in war-time, was an important health act as well as a new policy for education.

In industry, too, there were notable advances. The Factory Department was transferred to the Ministry of Labour and National Service in 1940, and played its part under that Ministry in mitigating the strains of war-time production and black-out conditions. The Factories (Medical and Welfare Services) Order 1940 had its outcome in the spread of medical and nursing services in industry, and in the multiplication of industrial canteens. The Ministry of Supply developed its own industrial medical service to control the serious toxic hazards in ordnance factories, and with a considerable measure of success.

Not least among the interests of this volume is the story of the health services of the Channel Islands during the German occupation. Finally, as a commentary on Britain in war-time, it is worth recalling that the first planning and negotiations for the National Health Service began early in 1943 when the end of the War was still very far from view.

J. H. F. BROTHERSTON

HEALTH AND SAFETY IN AVIATION

Human Factors In Air Transportation Occupational Health and Safety. By Prof. Ross A. McFarland. Pp. xv+830. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 108s. 6d.

IN an earlier book, "Human Factors in Air Transport Design", Dr. R. A. McFarland, who is professor of industrial hygiene at the Harvard School of Public Health, made an admirably bold

and very useful attempt to provide designers of aircraft with information about ways in which they should 'make allowance' for human capacities and inclinations in their aeronautical engineering. In the present book he goes several stages further and offers a multitude of facts and opinions to specialists in aviation medicine, personnel managers, safety experts, and to many more; and, as before, he performs his task in a thoroughly businesslike fashion. Not the least commendable feature of the book is its lucidity. There can be no doubt that from this point of view it will prove an unusually acceptable guide to the layman. Dr. McFarland takes an immense amount of trouble to make himself clear. This shows itself not only in his careful explanation of technical points in ordinary language, but also in his thinking about them (for example, in his use of the subtentative, assumption-free term 'accident repeater', on p. 78, for the adjectival, theory-ridden 'accident prone').

The ground he covers is clearly indicated in his well-planned contents pages. After an introductory chapter, which finishes with an assertion of the view that the ultimate success of air transportation will depend on the extent to which the characteristics of its operating and maintenance personnel are understood and the social habits and needs of its passengers recognized, he goes on to deal with the selection and training of flight personnel and the selection, placing and health of ground personnel. He ranges widely in these fields and presents a number of useful summaries of work done in them, particularly during the Second World War. But sometimes he attempts so much that he lays himself open to a charge of superficiality. Indeed, some of his efforts at condensation lead to rather puzzling statements. For example, on p. 41 he remarks, "Once the tests were found to be of predictive value, the next step was to determine a valid criterion for success in combat". He may perhaps argue that the context made it unnecessary to add the words 'for success in training' after 'predictive value', but surely the saving was scarcely worth while. Again, on p. 75 he appears to fall into the common trap of regarding rating scales as instruments for producing judgments rather than as mere recording devices. Faults of these kinds will not seriously diminish the value of the book to knowledgeable readers, but they may mislead the non-expert.

Dr. McFarland's chapters on safety on the ground and in flight make good reading, not least because they give him scope for his obvious taste—already displayed in his chapter on the indoctrination and training of flight crews—for formulating plain rules of procedure, securely rooted in careful reflexion on relevant evidence. He seems equally at home in his chapters on sanitation and health in airline operations; but—not unnaturally—he is rather less confident when he comes to examine problems arising in the care of passengers and the transportation of patients by air, for in many respects these must be regarded as relatively new. In his final chapter, Dr. McFarland discusses the organization and functions of air-transport medical programmes. So wide and deep is the territory he wants aviation medicine to annex, that a bystander may well wonder where people competent to administer it will be found in the numbers that this immense work will require. But no harm can be done by his thoughtful exposition of his grand ideas. Anyway, it makes a fitting end to a fascinating book.

ALDO RODGER

Organic Syntheses

An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. Vol. 32; 1952. Edited by Richard T. Arnold. Pp. vi+119. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 28s. net.

OF the forty-five preparations described in this volume, the first is an improved method for preparing abietic acid from wood resin; and the last deals with the conversion of 10-undecenoic acid into 10-undecynoic acid, the double bond being converted into a triple bond by successive treatment with bromine and sodamide. Other methods of introducing triple bonds are illustrated by the use of acetylene and of calcium carbide in the respective preparations of β -chlorovinyl isomyl ketone from isocaproyl chloride and of 1,1'-ethynylene-bis-cyclohexanol from cyclohexanone. The great variety of processes here displayed may be illustrated further by mentioning the preparations of alloxan monohydrate from barbituric acid, cyanogen iodide from sodium cyanide and iodine, 1,2-cyclohexanedione-dioxime from cyclohexanone, and cyclohexane sulphide from cyclohexene oxide. While a new method, due to Prof. T. S. Wheeler, is given for the direct production of flavone from *o*-benzoyloxyacetophenone and anhydrous glycerol, the application of the Baker-Venkataraman transformation is recommended because of the high yield and reproducibility of this procedure. Essential precautions and experimental detail are admirably set out: for example, in preparing 2,2-dichloroethanol from dichloroacetyl chloride and lithium aluminium hydride, the use of a good hood and a spark-proof motor is prescribed; glassware is dried by flaming during the passage of dry nitrogen, and directions are given for pulverizing the hydride. The subject index covers Vols. 30-32.

JOHN READ

Toxicity of Industrial Organic Solvents

By Ethel Browning. (Revised in consultation with the Toxicology Committee.) (Medical Research Council: Industrial Health Research Board, Report No. 80.) Revised edition. Pp. viii+412. (London: H.M. Stationery Office, 1953.) 35s. net.

IN this revised (1952) edition, Dr. Ethel Browning has summarized, in the light of the results of work published up to the year 1948, the toxic action of some organic solvents and the possible effect of this on the health of workers in industrial processes where these solvents are used. The summary includes both the older and better-known solvents, and also some which have only recently become available in commercial quantities. The new edition appears at an opportune time, since solvents of all kinds are being used in increasing quantities in a variety of industrial operations.

The arrangement of the subject-matter follows closely that adopted in the first edition. For each solvent the relevant physical properties are listed, together with the requirements of any existing recognized standard specification for controlling the quality and composition of the solvent. The importance of some knowledge of the chemical composition of the solvent, in relation to any toxic effect observed in its use, is indicated by the author in comments on the results of some of the published work. The symptoms which characterize cases of acute and chronic poisoning, in both animals and man, are fully described, and for a number of solvents

useful data are given as to what, in the opinion of some authorities, should be regarded as a maximum safe concentration of the solvent vapour in air.

The book is a worthy successor to the first edition, and should prove of considerable help to all concerned with the health of workers in the manufacture, transport or use of organic solvents.

Volumetric and Phase Behavior of Oil Field Hydrocarbon Systems

By Dr. M. B. Standing. Pp. vi+123. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1952.) 80s. net.

THE complex behaviour of varied types of hydrocarbon systems encountered in oilfield reservoirs has engaged the attention of petroleum engineers for many years past. Much has been done and much written on specialized methods of calculating pressure-production characteristics of subsurface oil and gas pools. This volume approaches the subject from the less conventional angle—co-ordination of laboratory measurement data on fluids, and the manner in which these data can be used to calculate actual reservoir behaviour. When we consider that under normal oilfield conditions vastly different hydrocarbon systems are co-existent; that types vary from a simple gas such as pure methane to the highly complex asphaltic bitumen; and that these types are constantly changing with pressure and temperature as affected by production; then it at once becomes apparent that problems to be faced require for their solution a sound knowledge of mechanism of fluid flow, thermodynamics and a nicely balanced interpretation of all facts elicited. Treatment of the subject in this book is systematic, based on division of hydrocarbon types into gases, condensate systems and dissolved gas systems. Phase behaviour of these systems, sampling of oil reservoirs and material-balance calculations support the discussion. Numerous charts are included to aid calculations for specific reservoir conditions, and the general set-up of text and clear printing add greatly to the value of the work, without which oil-pool specialists will lack a very modern approach to this ever-difficult subject.

H. B. MILLER

Contributions to the Theory of Nonlinear Oscillations

Vol. 2. By M. L. Cartwright, E. A. Coddington, H. F. DeBaggis, S. Lefschetz, N. Levinson, J. McCarthy, H. L. Turrittin. Edited by S. Lefschetz. (Annals of Mathematics Studies, No. 29.) Pp. vii+116. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1952.) 10s. net.

THIS monograph is a sequel to No. 20 of the same series. The following articles appear in it: Van der Pol's equation for relaxation oscillations (Miss M. L. Cartwright); perturbations of linear systems with constant coefficients possessing periodic solutions (E. A. Coddington and N. Levinson); dynamical systems with stable structures (H. F. DeBaggis); notes on differential equations (S. Lefschetz); a method for the calculation of limit cycles by successive approximation (J. McCarthy); and asymptotic expansions of solutions of systems of ordinary linear differential equations containing a parameter (H. L. Turrittin). These represent contributions to the theory of differential equations; and virtually no attempt is made to discuss physical significance, let alone practical utility of the topics discussed.

THE ROYAL SOCIETY OF ARTS

BICENTENARY CELEBRATIONS

THE first official meeting of the Society of Arts took place on March 22, 1754, and the exact anniversary two hundred years later fell on a Monday, so that the first day of a week of celebrations was also in some respects the most important.

On March 22, 1954, three events were arranged, two of them of more or less public character and the third private. The celebrations opened with a service at the Church of St. Martin-in-the-Fields, when the Society met probably for the first time in its history in such a building and for such a purpose. But the service was unusual not only because of its uniqueness in the Society's history, but also in its own character, and particularly from the musical point of view. As the organ was under repair, the singing was accompanied by an orchestra which, together with the choir, was provided by members of staff and students of Trinity College of Music, under the direction of the principal, Dr. Greenhouse Allt, who is a Fellow of the Society. One item of music was of special interest, the Trio Sonata No. 2 of Thomas Augustine Arne, who was one of the early members of the Society. The sonata has only recently been published, and this was probably its first public performance for 160 years. The execution of the music was throughout of a very high quality and the *Te Deum* (Vaughan Williams in G) in particular formed a most impressive climax to the service. The sermon was preached by the Bishop of Peterborough, who reviewed from the spiritual point of view the bewildering scientific and material progress of the past two hundred years and closed with the words of Francis Bacon: "The final end of all knowledge is the glory of the Creator and the relief of man's estate".

In the afternoon the chairman of Council, the Earl of Radnor, who is the lineal descendant of the Society's first president, Viscount Folkestone, received congratulatory addresses from representatives, in most cases the presidents, of nearly sixty other organizations, many of which, and in particular several from overseas, owe their origin in some degree to the activities of the Royal Society of Arts. It was a colourful scene as the representatives, many of them in academic robes, advanced singly, and with a quiet dignity befitting the eighteenth-century room in which the ceremony took place, to present the tribute of their organization. The ceremony concluded with a short address from Lord Samuel, retrospective but never nostalgic, in which he called upon the members of the Society of the present day to exercise the same faith and hope as moved the Society's founders and to sustain their good work for the sake of the generations that are still to come.

The day's events concluded in a more private manner, when the members of the Society's Council and their ladies dined informally at Tallow Chandlers Hall, and in this way commemorated the fact that the Society's first meeting took place in somewhat similar surroundings at Rawthmell's Coffee House. After dinner, students of the Royal Academy of Dramatic Art presented a scene from "She Stoops to Conquer": Goldsmith was not only one of the early members of the Society, but was also actually an applicant in 1760 for its secretaryship.

On the afternoons of Tuesday, Wednesday and Thursday a series of three masterly addresses was

delivered by Prof. N. B. L. Pevsner, Sir Ben Lockspeiser and Sir Geoffrey Heyworth, on the progress of "Arts", "Manufactures" and "Commerce" respectively during the past two hundred years, this pattern of themes being based on the Society's full title, "The Royal Society for the Encouragement of Arts, Manufactures and Commerce". Prof. Pevsner concentrated mostly on the history of industrial design during this period and, while recounting its promotion by the Society at various periods during the two hundred years, particularly emphasized the influence which it exerted in the years succeeding the Great Exhibition by its forthright attitude to contemporary design. Sir Ben Lockspeiser, in a survey of science in its application to industry during the past two hundred years, looked back, as it were, to Prof. Pevsner's lecture and emphasized the need for improved technology to go hand-in-hand with imaginative design, and looked forward to Sir Geoffrey Heyworth's subject, hinting at the contribution which science can now make to accountancy and many other clerical operations. In the last of the three lectures Sir Geoffrey Heyworth, in dealing with the subject of "Commerce", concentrated his attention upon the history of education for commerce, to which the Society itself has made and continues to make so important a contribution, and, in surveying the past two hundred years, he showed what had been achieved, first by the ordinary day school, then by institutions mainly operating in the evenings for specific training for commerce, and finally, through the acceptance of commercial subjects as appropriate to a university.

The fitting conclusion of the week's celebrations was a banquet, the first official dinner of the Society for ninety-two years, which was held at the neighbouring Savoy Hotel on Friday evening and at which T.R.H. the Duke and Duchess of Gloucester were present. Lord Woolton, a Fellow of the Society, represented Her Majesty's Government, and the Lord Mayor of London was there to represent civic government. In proposing the toast of the Society the Duke of Gloucester emphasized three aspects of its character; which he termed its disinterestedness, its humanity and its ability to combine the virtues of youth and age. Lord Radnor replied, and responses to the toast of the guests, which was proposed by Sir Ernest Goodale, were made by Dr. E. D. Adrian, speaking for the men guests and science, and Dame Ninette de Valois, representing the ladies and the arts. Dr. Adrian emphasized the influence which the Society, as a body interested equally in the arts and the sciences, could exercise towards securing that the discoveries of science were applied in a way that was beneficial and not harmful to the community, while Dame Ninette appealed to it for its support for the youngest of the arts.

Fortunately this festive week does not entirely complete the Society's celebrations of its bicentenary, as it is able to look forward to a reception which is being arranged to be held at St. James's Palace later in the year when its president, H.R.H. the Duke of Edinburgh, whose absence at this time was so keenly felt, can hope to be present.

In addition to these special events, the Society is commemorating its bicentenary by several actions of varying kinds. Its bicentenary competition, in which

deas of life in A.D. 2000 were invited, has already been announced. The Council has also decided to institute a medal, to be known as the Bicentenary Medal, which will be awarded annually to a patron of industrial design, and a new history of the Society prepared by Mr. Derek Hudson and the Secretary was published on the day of the bicentenary. Also,

a beautiful badge of office for the Chairman of Council designed by Prof. R. Y. Goodden has been presented to the Society by a former chairman of Council, Mr. J. A. Milne, and the Chairman was invested with this for the first time on March 17 in readiness for the forthcoming bicentenary functions.

KENNETH W. LUCKHURST

SUN NAVIGATION BY ANIMALS

By DR. H. KALMUS

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IT has for a long time been suspected that sun navigation must play an important part in the movements of homing and migrating animals; but until recently the evidence for its existence was not convincing, often contradictory, and the way in which it could work remained mysterious. However, experiments published during the past two years on honey bees¹, amphipods (*Talitrus saltator*)² and birds^{3,4} have not only demonstrated the existence of sun navigation beyond doubt, but have also shown that it is based in all three groups on a combination of two widely found faculties, namely, the perception and memory of angles and a change according to a twenty-four-hour rhythm of a reference system operating in the brain of the animal. As the orientational behaviour of honey bees is better known than that of the other species, it will be discussed first.

Worker bees, in a dark hive-like container, have been shown to perceive and to remember the angle between two straight parts of a learned track with great facility⁵, and it has long been established that in the outside world they make use of their sense of direction when flying between their hive and a feeding place⁶.

A combination of indoor and outdoor orientation is the basis of the bees' communication of direction: a forager by dancing on a vertical comb in the dark indicates, by the angle and direction of deviation from the vertical, the angle and direction of a rich source of food from the direction of the sun⁷.

It was believed for a long time, and on some evidence, that honey bees, once they have learned the angle between the sun and a source of food, will retain this angle unchanged in their memory and will accordingly, like certain ants⁸, strike out in a wrong direction, when they have been forced by the experimenter to remain inside the hive, the deviation depending on the length of their captivity. Lately, however, v. Frisch¹ has demonstrated that bees "when orientating with the aid of the sun, take the hour of the day into account". During several fine days he fed bees at an anise-scented syrup dish 200 m. west from their observation hive. The colony was then removed to a neighbourhood which was quite unfamiliar to the bees, and four identical syrup dishes scented with aniseed were laid 200 m. to the north, the south, the west and the east from the hive. Within three hours, twenty out of twenty-nine bees marked in the first location at the dish on the previous day were caught at the dish west of the hive and seven at the three others; and this happened although the sun had stood in the west when the bees had last fed at the first place, and in the east when they were caught at the second place. Repetitions of this type of experiment using additional precautions against other clues had similar

results; but the orientation broke down when the sky was overcast. Additional evidence for a mechanism compensating for the daily movements of the sun is provided by an observation by Lindauer¹ on an exceptional dancer, who after having found a dish did not leave the hive after 1-2 min. as is the rule, but continued to dance for eighty-seven minutes on a vertical comb. During this time the angle of the axis of the dance with the vertical changed by about 38°, while the movement of the azimuth at the place and time of the observation was 34.5°. Thus there can be little doubt that bees when finding a direction make use of some device which compensates for the daily movements of the sun or perhaps for the changes in the polarization pattern of the sky associated with it which they are known to use in other circumstances. While the possession of this compensating mechanism must be considered to be innate, its setting—like that of an automatic steering device—is effected for any situation, as opportunity arises.

The second example of sun navigation concerns the little crustacean *Talitrus saltator*, an abundant inhabitant of many sandy beaches in the Mediterranean. These animals when transferred inland will move at a right angle towards the coast-line from which they came, which will normally result in their regaining their habitat. Recently, Pardi and Papi⁹ have shown that to do so they make use of the position of the sun. When the sun was shielded from a few of these crustaceans and was replaced by its mirror image from the opposite direction they moved away from the shore instead of towards it. Like the bees, they could also orientate themselves when in the absence of direct sunlight, provided that some portion of the blue sky, but larger than that necessary for bees, was visible to them, and they could also be deflected by the application of a polarizing sheet. The directions of their movements were independent of the hour of the day, and thus of the changing position of the sun, but dependent on the place of origin of the animals: individuals from a population of the Tyrrhenic coast of Italy, for example, moved westwards, even when brought to the Adriatic coast, while the indigenous animals there moved eastwards. As with the bees, one must assume that the mechanism which compensates for the daily movements of the sun is innate in *Talitrus*, but unlike bees these crustaceans cannot set the geographical direction in which they move by individual experience; it seems to be set for each of them once and for ever either by heredity or by early individual experience.

Similar observations were also made on pigeons, starlings and other birds. Kramer¹⁰, experimenting with starlings, showed that these birds, like *Talitrus*,

have innate direction preferences, which come into play during migration, but that—like bees—they can also be trained to any geographical direction. In both reactions compensation for the daily movements of the sun was observed; but as might be expected from the structural differences between an arthropod's and a vertebrate's eye, the polarization of sky light does not play an important part in this. The innate preference for a particular geographical direction was established by closer observation of a well-known phenomenon: the migration during certain hours of the day of caged migrant birds. Young starlings of supposedly east Baltic origin, kept since July in an outdoor aviary in Wilhelmshaven, showed later in the season a distinct tendency to 'migrate' south-west, that is, in the direction of their presumed origin. This directional tendency was manifest in a round cage of about 2 ft. diameter; it persisted both in conditions which excluded the sight of the horizon and in the presence of great masses of iron, which greatly altered the direction of the compass needle. Orientated flight seemed impossible when the bird could not see the sky, or at least portions of it; but directional flight was observed when a starling was placed in the centre of a hexagonal pavilion, with six windows. When a mirror was attached to every window so that the incident light was deflected by 90° while the direct sky light was shielded off by a blind, the bird's main direction of flight was also deflected by 90° and in the same direction as the light. This type of experiment and similar ones showed that the migrating starling's behaviour was, in fact, governed by the incident light.

Kramer also performed experiments based on direction learning. Twelve equal feeders were placed in a circle around the starling on a movable ring, and covers were mounted on a second ring gliding upon the ring bearing the feeders, giving the experimenter great freedom of action. The food in the feeders was hidden from the birds and could be reached through a slotted rubber membrane. In the absence of landmarks starlings fairly soon learned to visit a feeder in a particular geographical direction, and after a fortnight some birds were perfect. Applying the mirror test as in the migration experiment, such trained starlings were deflected by 90°, thus showing that it was again the incident light which directed the bird. The 'right' feeder was also visited at various hours of the day, thus again showing that the daily movement of the sun was taken into account. On the other hand, it proved very difficult and took a long time to train a bird to keep visiting a feeder which was moved along during the days with the azimuth of the sun. Trained starlings did not perform well under heavily overcast skies, but orientated themselves to artificial light sources in place of the sun. Matthews⁴ has shown that pigeons can not only utilize the azimuth of the sun to get their bearings when returning to their loft from a direction to which they had been trained, but that many of them also return quickly from distant places in various directions. He has put forward a complex hypothesis to explain these results, in which it is assumed that the birds utilize not only the azimuth but also the altitude of the sun for their orientation.

The enumeration of these examples must make it unreasonable to doubt any longer the existence of diurnally changing reference systems for the sun orientation of many animal species. While one might be inclined to favour the simplest hypothesis which

can explain sun navigation, it may in fact be quite complex: there cannot be much doubt that moon-navigation would require very intricate astronomical reference systems; and yet many ornithologists believe in the moon navigation of night migrants, and it has also been fairly convincingly demonstrated for *Talitrus*⁵.

Geographical direction may play some part in the orientation of animals, other than when homing or migrating. Bees in the field, for example, seem acutely aware of the geographical direction; they could be easily trained to visit a dish on a card the western half of which was yellow while the eastern half was blue; they did not visit dishes on cards orientated in the opposite direction, and their visits on the correct cards were independent of the position of the feeding site in the field and of the hour of the day⁶. The well-known straight north-south orientation of the board-like mounds of certain North Australian termites¹¹ (*Hamitermes meridionalis*) may be another example of geographical orientation. While plausible ideas have been developed concerning the advantages of such orientation for the temperature regulation of the mounds, no hypothesis about the orientation of the termites during their building activity could previously be advanced. One now might perhaps assume that these termites also possess a brain mechanism which compensates for the daily movements of the sun.

The brain mechanisms which serve the sun navigation of the animals mentioned are presumably of a similar nature in all species and are probably based on the same principles as human sun orientation. They can also be expected to share certain properties with other time-keeping mechanisms (internal clocks) which are of wide occurrence¹²⁻¹⁴. They keep time fairly well on their own and they are set and kept in pace by light stimuli. Their metabolic nature has in certain cases been established¹⁵. A third property of such systems is that they regulate motor activities. *Drosophila*, for example, normally emerge from their pupae before dawn. If a bottle with larvae and pupae of *D. melanogaster* is artificially illuminated during three consecutive nights and kept in darkness during daytime, the flies which emerge during the following week will 'remember' the time of the artificial dawn and emerge in the evenings, even when now kept in perpetual darkness¹⁶. Examples of this sort could be multiplied; but while they would show that the elements for timing systems in animals very generally exist, they would not greatly add to our understanding of the details of sun navigation. These can only be explored by further experiments.

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PHYSICAL INSTABILITY AND THERMAL SHOCK IN RED CELLS

By DR. J. E. LOVELOCK

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THE idea that vital processes might be suspended at low temperatures has inspired attempts to preserve living cells in the frozen state. Success was rare because of the particularly destructive effects of the act of freezing and because it was not realized that each type of cell might require an individual technique of freezing. It was discovered in 1949¹ that the death of spermatozoa on freezing could be avoided if the cells were suspended in a medium containing glycerol, and this removed at one stroke the main barrier opposing the preservation of living cells in the frozen state. Since that time many types of living cell have been preserved successfully for long periods at low temperatures. It is found, however, that living cells do not necessarily survive indefinitely when their temperature is lowered to a level sufficient to reduce biochemical changes to a negligible value. The progressive loss of red blood-cells stored at -78°C . has been reported², and at this temperature also ovarian tissue may fail to survive even one week, although under otherwise similar conditions it survived a year or more at -190°C .³ It has been shown that most of the red blood-cells which do survive storage at -78° are not metabolically aged and behave normally on transfusion⁴.

The damage suffered by red blood-cells during freezing and thawing whether in the presence of glycerol or not is closely correlated with the greatly increased concentration of electrolytes which occurs when water is removed as ice^{5,6}. The exposure to concentrated salt solutions causes first an increase in the permeability of the cell membrane and finally complete dissolution of the cell. This appears to be due to the dispersion of lipids and lipoprotein from the cell membrane under the influence of the solvent action of concentrated salts. Glycerol protects against the immediately destructive action of freezing by reducing the concentration of salts in equilibrium with ice at a given temperature. If the proportion of molecules of glycerol to those of salt is sufficiently high, the concentration of electrolytes never reaches an immediately damaging level during freezing or thawing. The presence of glycerol does not, however, completely prevent the concentration of salts, and cells stored at low temperatures in the presence of glycerol are exposed continuously to relatively concentrated salt solutions. The possibility therefore arose that the observed rapid destruction of red blood-cells by concentrated salt, and the slow deterioration in less concentrated solutions were due to the same process operating at quantitatively different levels. It also seemed possible that the observed improvement in the survival of red blood-cells at 4° and at -20° in media containing sodium citrate instead of sodium chloride was due to the lower solubility of the cell components in sodium citrate. These suggestions have received support from the observation that the survival of red blood-cells in the frozen state is much improved if the salt concentration of the suspending medium is kept as low as possible. This has been done either by increasing the concentration of glycerol^{8,10} or decreasing the concentration of salt¹¹

in the suspending medium before freezing. More direct evidence comes from the chemical analyses of stored cells. Those kept in unfavourable media at temperatures between 0° and -78° are found to have lost considerable quantities of their membrane components.

In the course of experiments designed to determine in greater detail the destructive processes occurring during the storage of red blood-cells at low temperatures, some observations of a more general interest have arisen—in particular, observations relevant to the structure and status of the cell membrane, and to the phenomenon of thermal shock, that is, the destruction of living cells which sometimes occurs on sudden chilling. There follows a preliminary account of these observations.

The experimental investigation of the decay of living cells stored at -78° is necessarily slow. An attempt was therefore made to reproduce these changes above 0° . Red blood-cells were suspended in a medium kept unsaturated with respect to the components of their membranes. This was done either by repeated washing, or by including a neutral absorbent substance such as alumina in the suspending medium.

It was found that lipids and lipoprotein rapidly diffuse from red blood-cells suspended in fresh 0.16 M sodium chloride. After about 3 min. an equilibrium level of these components is reached and the loss from the cell falls to a low value. The equilibrium concentration of lipids and of lipoprotein in the suspending medium did not appear to represent a simple saturation of the medium with these substances. The concentration depended upon the previous treatment of the cells. It increased with the length of time the cells had been stored and decreased with the number of times they had been washed. With fresh cells washed five times in 0.16 M sodium chloride the concentration of lipids in the suspending medium is, normally, cholesterol 22, phospholipid 20, and lipoprotein (N) $18\text{ }\mu\text{gm. per ml.}$ If washing is repeated ten or more times the cells are reduced to a condition similar to that found after prolonged storage at low temperatures. There is loss of components from the cell sufficient to cause a volume reduction of 10–20 per cent. Cells in this condition do not haemolyse more rapidly than fresh cells when suspended in 0.16 M sodium chloride; but if washing is further continued, lipids and lipoprotein are released into the suspending medium only in proportion to the fraction of cells which haemolyse. It is almost as if a proportion of the cells were sacrificed to maintain a necessary minimum concentration of cell components in the suspending medium.

An even more convenient method of investigating the diffusion of components from the red blood-cell is to include a neutral absorbent with their suspension. In practice it is found that a rapid removal of lipids and lipoprotein, and slow progressive lysis take place if cells and chromatographic alumina are suspended together in 0.16 M sodium chloride in the proportion of 1 ml. of cells to 1 gm. of alumina. The results of a typical experiment are shown in Table 1. Using this technique it was possible to investigate the

Table 1. THE LOSS OF COMPONENTS FROM THE HUMAN RED BLOOD-CELL WHEN EXPOSED TO ALUMINA

Conditions	Quantities of membrane components from 1 ml. of red blood-cells remaining after various treatments (units: mgm. and ml.)					
	Cholesterol	Phospholipid	Lipid N	Volume	Hæmoglobin	Dry weight of lipids
Fresh cells	1.21	2.7	0.24	1.0	345	12
After 15 min. with 1 gm. alumina per ml. of cells at 37°	1.09	2.15	0.15	0.75	340	7
After 1 hr. at 37° in plasma	1.13	2.90	0.15	0.75	340	7
Lost from cells	0.12	0.55	0.09	0.25	5	5
Recovered from alumina	0.12	0.80	0.08	—	0	4.5

diffusion of various cell components and the rate of hemolysis of the cells, at different temperatures. It was found that between 40° and 5° the rate of hemolysis of cells in the presence of alumina decreased in a manner suggestive of a process governed by simple diffusion, that is, with an activation energy of 5,500 calories. At 4° the rate of hemolysis began to increase as the temperature was further lowered, and at the lowest temperature so far investigated, -5°, was still increasing. There was also, at temperatures below 4°, a decrease in the rate of diffusion of cholesterol and phospholipid from the cell. These results suggest a change in the state of the cell membrane at 4°. In this connexion it is particularly interesting to note that 4° is usually recommended as a better temperature for the routine storage of red blood-cells than 0°¹³. Another point of interest is that the effects of alumina, like those of washing, are strongly influenced by the past history of the cells. Cells stored ten days in 'acid citrate dextrose' plasma at +4° hemolyse in the presence of alumina twice as quickly as fresh cells.

Unlike the diffusion of superficial protein from the red blood-cell¹³, the loss of lipoprotein does not appear to be simply reversible. Cells which have lost 40 per cent of their lipoprotein and 25 per cent of their volume are still in this condition after storing for one hour at 37° in a large volume of fresh plasma. On the other hand, P. L. Mollison, in a personal communication, reports that cells which have been washed seven times, and also a considerable proportion of cells withered by storage for long periods at low temperatures, survive normally on transfusion.

It is well recognized that the fluid contents of living cells are maintained at their normal levels by active processes against loss by diffusion. It is also recognized that damage can result at low temperatures from the greater reduction of metabolic activity as compared with diffusion¹⁴. The ability of

the normal red blood-cell to synthesize cholesterol¹⁵ and other membrane components¹⁶ has been shown. This, together with the evidence above, suggests that not only the fluid contents but also the structure of the red blood-cell is maintained by a combination of synthesis and of passive diffusion from the plasma. So far as the red blood-cell is concerned, in the lease of life the tenant is responsible not only for interior decoration but also for structural repairs. The failure of the repair processes appears to be the first cause of death of red blood-cells during cold-storage in their normal medium.

It is important to note that the death of red blood-cells stored in plasma containing sodium citrate (acid citrate dextrose) at +4° and also possibly in an equivalent medium with glycerol at -22°¹⁷ does not appear to be due to physical dissolution. Cells stored under these conditions do not, while alive, lose their membrane components, and those which survive do not live as long as normal cells when transfused. Thus, the physical breakdown of cells which occurs during cold storage in their normal media can be avoided by a suitable choice of storage conditions, at least until death occurs from other causes. The most suitable media for the storage of red blood-cells seem to be those in which the solubility of the cell components is least: namely, slightly acid media containing a salt, such as sodium citrate or acetate, the anion of which is more hydrated than the chloride ion.

Thermal Shock

The loss of lipids in an indiscriminating manner by simple diffusion appears to cause no great harm to the red blood-cell. In contrast, the loss of phospholipid selectively renders the cell metastable and subject to rapid lysis on cooling below 20°. The selective removal of phospholipid can be achieved practically by three methods. First, as is well

Table 2. THE LOSS OF COMPONENTS FROM HUMAN RED BLOOD-CELLS FOLLOWING THE VARIOUS TREATMENTS DISCUSSED IN THE TEXT

Treatment or storage conditions	Loss of cell components (per cent)					
	Cholesterol	Phospholipid	Lipid N	Volume	Hæmoglobin	
10 days at 0° in 0.16 M NaCl + 0.2 per cent glucose buffered to pH 7.0	23	22	46	—	5.0	Unfavourable storage conditions
14 weeks at -22° in 0.11 M sodium citrate + unbuffered 30 per cent glycerol	23	27	51	40	2.6	
1 year at -78° in 0.16 M NaCl + 16 per cent glycerol	17	22	29	20	6.0	
10 days at 0° in 'A.O.D.' plasma	5	7	0	0	1.0	Favourable storage conditions
14 weeks at -22° in 'A.O.D.' plasma + 30 per cent glycerol	0	0	0	0	1.8	
15 min. at 37° with 500 mgm. alumina per ml. of cells	14	16	36	17	1.0	Simulated unfavourable storage
20 washings at 37° in 0.16 M NaCl + 0.2 per cent glucose	15	15	29	13	2.7	
1 hr. at 0° in 0.03 M NaCl	9	26	12	—	1.7	Conditions causing sensitivity to thermal shock
1 hr. at 37° in 0.16 M NaCl containing 5.0 mgm. per ml. of detergent D ₁₁	10	22	18	—	0.3	

known¹⁸, by treatment with bacterial toxins, in particular, the toxin of *Cl. welchii*; secondly, by exposure to 1.0 M sodium chloride¹⁹; and thirdly, by means of selective absorbing substances, for example, certain anti-tubercular, macro-molecular detergents¹⁹. The effect of one of these substances, prepared by condensing *p*-tert-octyl-phenol formaldehyde resin with ethylene oxide, is shown in Table 2.

Some other living cells in their normal state show a similar sensitivity to cooling. This was first investigated with mammalian spermatozoa²⁰, and is usually referred to as thermal shock. An excellent review of this effect, which is found with a wide variety of living cells, has recently been written²¹. There is a considerable body of evidence to suggest that the lysis of red blood-cells which have lost some of their phospholipid, and the destruction of normal living cells by sudden cooling, are manifestations of the same general phenomenon. Thus, thermal shock with mammalian spermatozoa is reduced by treating the cells with lecithin before cooling²². It is increased if the cells are treated with the α toxin of *Cl. welchii* or with the macro-molecular detergent described earlier. Conversely, red blood-cells which have been denuded of phospholipid can be protected against thermal shock if they are suspended in a medium containing lecithin.

The destructive effects of thermal shock take place with great rapidity. Red blood-cells rendered sensitive to thermal shock hemolyse within 30 sec. if suddenly cooled from 37° to 0°. If they are returned to 37° after spending only one second at 0° they hemolyse just as rapidly. Thus, the destructive effect of cooling takes place within one second, and may well be faster even than this.

The physical factors which appear to be important in the production of thermal shock are the temperature of the cell and change of temperature to which it is subjected. The rate of change of temperature if faster than 0.1 deg. per sec. and the gradient of temperature across the cell are relatively unimportant. The effect can occur at temperatures as low as -30°²¹. There is therefore considerable circumstantial evidence to suggest that the effect results from some physical change in the cell membrane at low temperatures.

The change in the chemical structure of the cell which confers sensitivity to thermal shock appears to be an increase in the ratio of cholesterol, or possibly the cholesterol lipoprotein complex, to lecithin in the cell membrane. The alteration of this ratio either by removing lecithin or by adding cholesterol increases the sensitivity to thermal shock. The absolute amounts of these lipids are relatively unimportant.

The observations upon the breakdown of red blood-cells by diffusion and by thermal shock provide some evidence concerning the status of the components of the cell membrane. They suggest that some of the phospholipid and cholesterol of the cell are free to diffuse reversibly, and that lipoprotein is free to diffuse away from the cell but does not return by the same route.

The classical view of the structure of the red blood-cell membrane implies a framework of stroma surrounded by a bimolecular layer of lipids, with a sprinkling of antigenic and antisphering protein at the surface. It seems unlikely that a cell possessing such a structure could lose a substantial portion of its membrane components and yet remain intact. Among more recent views upon the architecture of

human red blood-cells are two which agree quite well with the experimental results outlined above. The first²³ suggests a membrane composed of lipoprotein the concentration and orientation of which diminish radially inwards. The second²⁴ envisages a membrane composed principally of fibrils, of a lipoprotein called elinin arranged parallel to the cell surface and cemented together by ether-soluble lipids. The idea that the lipoprotein of the cell membrane is held at a preferred orientation fits harmoniously with the observed irreversible nature of its diffusion. If the cell membrane is relatively thick, as recently proposed²⁵, some loss of its components could presumably be borne without the destruction of its function as a permeability barrier. The observed volume changes are also in good agreement with those of a hypothetical cell with a thick membrane composed of a 2 per cent lipoprotein gel.

The orientated lipoprotein of the cell membrane is thought to be cemented together by ether-soluble lipids²⁴. If this hypothesis is accepted, it provides grounds for an attractive speculation concerning the mechanism of thermal shock. If the cement is made from a mixture rich in cholesterol, it is likely to be brittle at low temperatures. The mechanical stresses resulting from a change in temperature could then cause the cement to fracture, and destroy the permeability properties of the membrane. Whatever is the true function of the various components of the cell membrane, the physical factors upon which thermal shock is observed to depend make it probable that the phenomenon depends upon some mechanical failure at least similar to that suggested.

The experimental results reported in this paper form the subject of a more detailed account which will be published later.

I am indebted to Dr. A. S. Parkes for his interest and advice. My thanks are also due to Dr. P. L. Mollison for making freely available the results of his investigations, and for supplying samples of frozen and stored blood. I also wish to acknowledge the skilful assistance of Miss G. O. McMahon.

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OBITUARY

Sir John Myres, O.B.E., F.B.A.

SIR JOHN MYRES, emeritus professor of ancient history in the University of Oxford, died peacefully on March 6, at his home in Oxford, aged eighty-four. The world of scholarship and his many friends will feel a grievous sense of loss.

Few, if any, in the past half-century strove more devotedly and clear-sightedly than he in the allied fields of archaeology and anthropology, not only in a great output of influential books and articles, but also in vigorous executive action. As a geologist and a geographer, too, he held an honoured place. His broad humanism, capacity for intensely hard work, and expressive prose style which clarified difficult subjects with wit as well as wisdom, were the inheritance from the confident, all-inquiring era of the later nineteenth century. The bold sweep of such wide humanism, unafraid of the great problems which humanity has to face, but not pedantic, without dogmatic ideology, and founded firmly on fact, is more needed to-day than ever.

A scholar of Winchester and of New College, Oxford, his gifted versatility was evident from the start. In 1892 he won a Craven fellowship for classical studies in Greece, and also the Burdett-Coutts scholarship in geology. It is not possible to enumerate all the distinctions which followed throughout a long life, lived to the last with outstanding energy, courage and cheerfulness. He was a Student of Christ Church during 1895-1907, and then was elected professor of Greek in the University of Liverpool. In 1910 he returned to Oxford as Wykeham professor of ancient history, and held the chair until 1939. During 1919-32 he was general secretary of the British Association, a vice-president of the Society of Antiquaries from 1924 until 1927 and gold medallist in 1942, a past-president of the Royal Anthropological Institute, Victoria medallist of the Royal Geographical Society and chairman of the British School at Athens during 1934-37. He was honoured by doctorates from the

Universities of Wales, Manchester, the Witwatersrand and Athens.

His adventurous career as a lieutenant-commander and later commander (R.N.V.R.) in the Aegean during the First World War has an almost legendary fame, in the Minoan and Homeric tradition. For his exploits, notably against the Turkish coastal garrisons, he was made a Commander of the Royal Order of George I of Greece. He received his knighthood in 1943.

Where others would have relaxed their efforts, Sir John Myres redoubled his. The last three books he wrote, "Scripta Minoa II", "Geographical History in Greek Lands" and "Herodotus: Father of History", all appeared after his eightieth birthday (which had been celebrated by a special number of the journal *Man*).

Methods and aims in education in schools and universities interested him greatly, and his combination of imagination with shrewd common sense gave his colleagues many a lead to follow. His practical qualities shone in administration, and to him goes a large measure of the credit for initiating International Congresses in Prehistoric and in Anthropological Studies, which now meet at regular intervals.

His aim was to encourage people to think for themselves, and think clearly. His personal preference was for difficult problems which went to the heart of human history and action, as shown in his famous volume "Who Were the Greeks?". But it was perhaps in personal contacts that he exerted his greatest influence. He was always accessible, helpful, frank; and especially ready to encourage young men. To visit him and discuss one's work was inspiring, for he had a truly noble mind, and one never departed without several valuable new ideas that had been good-naturedly suggested.

Those who had the privilege of knowing him—and they are scattered all over the world—understood how greatly he was sustained, especially in the infirmities of his later years, by the devoted care of Lady Myres. His surviving son, Mr. J. N. L. Myres, is Bodley's Librarian.

JOHN BRADFORD

NEWS and VIEWS

Agriculture In Great Britain:

Sir James Scott Watson

SIR JAMES SCOTT WATSON, chief scientific and agricultural adviser to the Ministry of Agriculture and director general of the National Agricultural Advisory Service, is retiring on December 31 next, shortly after his sixty-fifth birthday. After graduation at Edinburgh and advanced study in Berlin and at the Iowa State College, he joined the agricultural staff at his old University. During the First World War he served with the Royal Field Artillery in France. During 1922-25 he was professor of agriculture and rural economy at Edinburgh, going thence to the Sibthorpe chair of rural economy at Oxford, which he occupied until 1944. The Second World War took him away from academic life, his important duties including membership of the Scientific Food Committee and during 1942-44 the post of agricultural attaché at the British Embassy, Washington. Returning, he became chief education and advisory officer in the Ministry of Agriculture, and in 1948 moved to the post he is about to relin-

quish. Sir James's exceptionally wide and profound range of agricultural knowledge in the detail of practice, in the applications of science, in history and in national economic aspects, have made him for many years an outstanding authority. His ease and clarity as a writer have enriched the literature with many papers and some excellent books including the famous "Agriculture: the Science and Practice of British Farming", everywhere known as "Watson and More". Broadcast talks, lectures and official work have made him widely known and greatly respected among farmers, and his editorship of the *Journal of the Royal Agricultural Society* from 1931 until 1945 widened still further his influence on agricultural teaching and thought. To him, as its first head, fell the launching of the National Agricultural Advisory Service, instituted in 1946. He is a member of the Agricultural Research Council and was knighted in 1949.

Prof. H. G. Sanders

PROF. H. G. SANDERS, who is to succeed Sir James Scott Watson as chief agricultural and scientific

adviser to the Ministry of Agriculture, was born in 1898 and is at present professor of agriculture at Reading. From Wellingborough School he joined the Royal Field Artillery in 1917, served in France and on demobilization went up to St. John's College, Cambridge, where he studied agriculture. Interest in experimental husbandry drew him away after a short spell of practical farming, and during 1922-29 he was on the staff of the Animal Nutrition Institute (then in Cambridge) engaged on statistical analyses of lactation phenomena and other cattle physiology topics. Turning then, with great success, to the teaching of crop husbandry, he became a University lecturer in the School of Agriculture, Cambridge, filling that position until 1944, when he was elected to the professorship at Reading. In fruitful partnership with Mr. F. H. Garner, he completed well-known field-experiments on plant populations and yield in potatoes, cereals and sugar beet, on cultivations and in the then novel use of grass and lucerne mixtures. He was elected to a fellowship at St. John's in 1944 and in 1939 published "An Outline of Crop Husbandry", still a standard text. As executive officer of the Hertfordshire War Agricultural Executive Committee, 1941-44, he achieved notable success in the stiff war-time tasks of the county. In the Agricultural Improvement Council of England and Wales he has played a leading part in developing the regional husbandry experimental farms supported by the Ministry. He is a member of the University Grants Committee. Both academic and farming circles will welcome the appointment.

Pathology at Sheffield: Dr. D. H. Collins, O.B.E.

DR. D. H. COLLINS, reader in clinical pathology in the University of Leeds, has been appointed to the chair of pathology in the University of Sheffield in succession to Prof. H. N. Green, who has taken up the chair of experimental pathology in the University of Leeds (see *Nature*, December 5, p. 1028). Dr. Collins was educated at Rossall School and the University of Liverpool, where he graduated in medicine in 1930, taking his M.D. three years later. In 1934, after various hospital and university appointments in Liverpool, he became the first Rheumatism Research Fellow in the University of Leeds and held this fellowship until the outbreak of the Second World War, when for the next seven years he was seconded to the Emergency Pathological Service. After establishing a base-hospital laboratory at Scotton Banks Sanatorium, Dr. Collins went to Sheffield in May 1940 as pathologist to Wharfedale Emergency Hospital, later becoming medical superintendent of the Hospital in charge both of its pathological services and its medical administration. In October 1946 he returned to the University of Leeds as reader in clinical pathology. Apart from his work on a number of medical advisory committees and being an assistant editor of the *Journal of Pathology and Bacteriology*, Dr. Collins's main research interests are centred on disease of the bone, and he is the author of the book "The Pathology of Articular and Spinal Diseases".

Civil Engineering at University College, Swansea:

Dr. B. G. Neal

CONSIDERABLE developments have taken place during recent years in the School of Engineering at Swansea under the direction of Prof. L. J. Kastner. Opportunity has now been taken to institute a chair in civil engineering, and the first professor of this

subject will be Dr. B. G. Neal, who will take up his appointment on October 1 next. Dr. Neal obtained first-class honours in the Mechanical Science Tripos at Cambridge in 1942, being awarded the Rex Moir, Ricardo and John Bernard Selly Prizes. For the next three years, as a temporary experimental officer, he was concerned with naval aircraft work, and in 1945 represented the Department of Scientific and Industrial Research at the Underwater Ballistics Conference in Washington. A later period in the United States was spent on research on plastic theory at Brown University, R.I., under Prof. W. Prager. Apart from this, his research work has been at Cambridge, where he is a Fellow of Trinity Hall and lecturer in engineering. A paper on the lateral instability of yielded mild steel beams was published by the Royal Society. Publications on framed structures under repeated loading gained for Dr. Neal and his collaborator the Manby Premium and the Telford Premium of the Institution of Civil Engineers, and he is at present completing a book on analytical methods of plastic theory.

Abbreviation of Bacterial Generic Names

WHEN using the binomial system of nomenclature, bacteriologists often contract or abbreviate the generic name; there are no rules to guide them, and each author may create his own shortened form. What form appears in print depends on the editorial policy of the particular journal, and in this there does not seem to be a common practice. The abbreviations used in the "World List of Scientific Periodicals" are based on the general and special rules of the International Code of Abbreviations for Titles of Periodicals, but similar rules do not exist for the generic names of bacteria. The Bacteriological Code of Nomenclature does not recognize the abbreviation of generic names, which seems to be a labour- or space-saving device resorted to by authors and editors. A preliminary inquiry is being made to find out if there is a demand from editors for the standardization of these abbreviations, and it is hoped to collect information on the present policy of certain journals published in the English language, some of which use single-letter abbreviations and others use rather longer forms. The inquiry was started in relation to the abbreviation of generic names of bacteria, but other points have been raised by individual editors. Those who hold views on this and related subjects are asked to get in touch with Dr. S. T. Cowan, the joint secretary (representing medical bacteriology) of the International Committee on Bacteriological Nomenclature, at the National Collection of Type Cultures, Colindale Avenue, London, N.W.9.

Figuring of Types in Entomology

At a meeting of the International Union of Biological Sciences, held at Nice during August 1953, a type-figuring sub-section of the Entomology Section was formed, and its activities are now directed by a committee of fifteen under the chairmanship of Mr. N. D. Riley, keeper in the Department of Entomology, British Museum (Natural History), London. The objective of the sub-section is to make as readily available as possible information on types of insects and other animals, especially by distributing figures of the type specimens, to assist in research work and to have some information available in case types are accidentally destroyed. It is proposed to collect in a central file negatives of photographs of type speci-

mens, or of photographs of drawings or other illustrations of type specimens or of their parts; to catalogue these and make lists available from time to time; to make and to distribute prints of the photographs for suitable fees to those requesting them; and, when finances permit, to make or arrange to have made illustrations of types for the central file. The sub-section is run on a non-profit basis, and in fact will operate at a financial loss until receipts from the sale of prints cover expenses or until grants are obtained. The chief need at the moment is for negatives or other illustrations for the central file, unpublished illustrations being, of course, the most desirable. At present the headquarters of the sub-section and the central file are in Ottawa, and all correspondence should be addressed to Mr. P. F. Bruggemann, Curator, c/o Division of Entomology, Science Service Building, Ottawa, Ontario.

A Faked Fossil

IN the *Museums Journal*, March 1954, Mr. H. F. Whitworth, of the Geological and Mining Museum, Sydney, exposes the faked nature of an insect wing in a specimen of selenite. Presented to the Museum in 1912, this was examined by Dr. R. J. Tillyard, who with some hesitation was eventually convinced of the genuineness of the 'fossil' and stated that it belonged to the Tertiary age and was unlike any living form. He placed it within the family Tettigoniidae and named it *Austrodictya corbouldi*. Recently, the specimen has been re-examined and it was seen that the crystal of selenite has been opened by a knife, the wing inserted and the edge of the crystal pounded in an endeavour to hide the crack produced. Experiments showed that the flexible nature of selenite allowed this operation to be carried out easily. The wing has now been identified as the forewing of *Terpandrus horridus*, a present-day form, commonly known as the great gum-tree grasshopper.

Latin American Research in Parasitology

THE third report in the series, "Latin American Contributions to Scientific Progress", is entitled "Parasitology 1949-50" (pp. 287; Montevideo: Unesco Science Co-operation Office for Latin America, 1953), the two previous publications being concerned with chemistry and with mathematics, respectively. The object of the series is to make known to a much wider public than at present the contributions that Latin American scientific workers are making in various fields. The present report, which is by Prof. J. E. Mackinnon, in collaboration with Prof. S. B. Pessoa, Prof. F. Pifano and Dr. A. Trejos, is concerned with the publications in the field of parasitology that appeared during the years 1949-50. Parasitology is a field that has close association with other studies such as pathology, hygiene, etc.; but while clinical and surgical references appear in the bibliography, the reviews themselves are concerned almost exclusively with experimental and descriptive parasitology, although a certain amount of attention is given to epidemiology and prophylaxis since they are closely related to the biology of the parasite. The reviews are divided into a series of chapters under the five headings protozoa, helminths, arthropods, fungi and various, occupying pp. 14-250, and the bibliography occupies the remaining thirty-seven pages. There are about eleven hundred references, and from this bibliography the titles of the publications, the names of the workers and their fields of study can be found, all of which is most useful information. The authors

are Latin Americans or come from other countries but live and work in institutions in Latin America. Naturally, some publications of importance to Latin America come from European possessions or from Panama, and these have been dealt with in their appropriate places by footnotes and do not appear in the body of the text or in the bibliography. On the whole, the English is good; but there are some slips: for example, "flies" as the plural of fly, "on account of" instead of "as shown by" and so on.

Diploma in Health Education

ONE of the greatest handicaps to health education has been the lack of properly qualified people. It is hoped that this weakness will be remedied by the proposal of the Institute of Education (University of London) to offer a comprehensive course in health education. It is intended to give a professional training to doctors, nurses, teachers and others with suitable experience, in the basic disciplines and practice of health education. The course will last a year and lead to a diploma of the Institute. The syllabus will deal with the principles of education; principles of social and preventive medicine, including epidemiology and vital statistics; the history and administration of public health and of education; the scientific bases of health and human behaviour with particular emphasis on heredity and genetics, growth and development, environmental hygiene, and the general principles of the causation, spread and prevention of infective disease; and the principles, methods and media of health education. Field-work will form a part of the course and visits will be made to illustrate the work of hospitals, clinics, local health authorities, schools, youth clubs and industrial concerns.

From the content of the course it would seem that students who obtain the diploma will be qualified to plan and administer comprehensive health education programmes, as well as having the practical experience of the health teacher. A feature of particular interest is the opportunity of providing a tailor-made syllabus for each student to ensure that those with a medical background devote more time to studying education, and vice versa. Sponsors of the course are the London School of Hygiene and Tropical Medicine, the Institute of Child Health and the Central Council for Health Education.

Auxin and Mushroom Growth

I. M. FRASER (*Austral. J. Biol. Sci.*, 6, 379; 1953) reports that the cultivated mushroom, *Pleurotus hortensis*, var. *albida*, was unable to grow appreciably on a liquid medium containing only glucose, asparagine and mineral salts. Growth was slightly increased by additions of thiamin and biotin to this medium; but a number of other vitamins were without effect. Indole-3-acetic acid, however, in concentrations of 5-100 mgm./l., produced a very notable increase in growth, particularly with biotin and thiamin present, but only in surface culture. The growth of both floating and submerged inocula was markedly increased by additions of yeast extract, cotton wool extract, or mushroom compost extract, although these did not appear to contain appreciable quantities of indole-3-acetic acid. The fungus grew fairly well on basal medium solidified with agar which had been purified to remove vitamins. Addition of thiamin or biotin did not promote growth. Concentrations of indole-3-acetic acid of 10 and 100 mgm./l. almost completely prevented initial growth,

while concentrations of 0.001, 0.1 and 1.0 mgm./l. were without effect. However, after about thirty days, vigorous growth commenced in the medium originally containing 10 mgm./l. indole-3-acetic acid and proceeded at the same rate as in its absence. It seems probable that this was due to inactivation of the indole-3-acetic acid by the small amount of mycelium formed. It is suggested that indole-3-acetic acid may play a part in the growth processes of this fungus similar to that in higher plants, although the possibility that some related substance such as tryptophan is required for growth must also be considered, particularly in view of the unidentified growth-promoting factor present in various extracts.

Dissemination of Rust Fungi in India

In Scientific Monograph No. 18, published in 1952 by the Indian Council for Agricultural Research, Prof. Mehta, of Agra College, has presented a detailed account of a study of the dissemination in India of three rusts of wheat and barley, *Puccinia graminis tritici*, *P. triticea* and *P. glumarum*. The work was carried out mainly between the years 1932 and 1938 and is a continuation of that reported earlier in Monograph No. 14. By means of slide traps on stationary aeroscopes or on kites, balloons or aeroplanes in the vicinity of some twenty stations throughout the country, Prof. Mehta has compiled estimates of the aerial distribution of the fungi and related these data to the trajectories of relevant winds and the incidence of disease outbreaks. The results, presented as a series of maps and tables in the monograph, showed that spore showers preceded outbreaks of rust at most stations and that winds usually came from places where the diseases had been prevalent from fifteen days to two months previously. Such sources of inoculum usually originated in the hills, where an early crop was sometimes grown or developed from tillers or self-sown plants, becoming infected earlier than that in the plains. These findings are discussed and the conclusion reached that the most important foci for the dissemination of rust inoculum lie in central Nepal, the Nilgiris and the Palni hills, and that early spread from these regions to the Indo-Gangetic plain and Peninsular India, respectively, is chiefly responsible for outbreaks experienced there. In a final section the author briefly reviews the situation and makes proposals for the control of these rusts in India. Measures recommended for specified hill regions include suspension of the early crops of wheat and barley, destruction of self-sown plants and stray tillers between seasons and postponement of sowing to coincide with that in the plains.

Graphs of the Compton Energy-Angle and the Klein-Nishina Formula

CIRCULAR 542 of the National Bureau of Standards, Washington, D.C., is primarily a representation in graphical form, by Ann T. Nelms, of the Compton energy-angle relationship and the differential and integral Klein-Nishina cross-sections as functions of the energy and direction of the scattered photon and of the recoil electron (pp. iv + 89. Washington: Government Printing Office, 1953; 55 cents). Unpolarized primary gamma-rays in the energy-range 10 keV.-500 MeV. are considered. It is stated that interpolated values may be obtained from the curves with an accuracy of 2 per cent. The data are expressed in the units used most often by experimentalists and are based on DuMond and Cohen's (1951) values of

the fundamental constants. The graphs are preceded by a discussion of the various experimental, theoretical and mathematical considerations involved in the relationships finally chosen for computation and representation. The Circular represents the fourth item in a series of surveys and tabulation of information on radiation physics carried out with the support of the Biophysics Branch of the United States Atomic Energy Commission. The three previous items have been given limited circulation.

Webster Plass Collection of African Art

THE late Mr. Webster Plass, of Philadelphia, and his wife collected for many years examples of African works of art. Mr. Plass always wished that his collection would eventually find a permanent home in the British Museum, and Mr. William Fagg, assistant keeper in the Department of Ethnography, has now compiled a memorial catalogue of the collection. Bearing the title "Webster Plass Collection of African Art" and the sub-title "Catalogue of a Memorial Exhibition held in the King Edward VII Galleries of the British Museum", this catalogue has been published by the British Museum, the cost having been borne by Mrs. Plass (pp. 47 + 48 plates; 1953). There are forty-six pages of illustrations of works of art made by various Central and West African peoples, and these are described in detail in the catalogue. There is also a map showing the distribution of their makers. The whole is well and clearly set out, and Mr. Fagg is to be congratulated on his work. It is a pity, perhaps, that the paper on which the half-tones are printed could not have been of a rather better quality. The reproductions are good but could have been even better. There is a short introduction on African art in general.

Stanford University Natural History Museum

THE main fish and herpetological collection rooms of the Natural History Museum of Stanford University have recently been entirely refitted at a total cost of 30,000 dollars, 93 per cent being raised by a graduate students' Zoology Project Fund to which many graduates and friends of the University have contributed. The fish collections have been supplied with 9,000 sq. ft. of new steel shelving which will increase the fish research space by two-thirds. Modern lighting has been installed and also a new electric 'dumb waiter' to connect the double-decked fish collection with other floors in the building, so that the Stanford collection, which contains about 750,000 specimens, is now one of the best-housed in the world. It has also been possible to utilize the old shelving for renovating the herpetological collection facilities, thus increasing their shelf-space by 100 per cent.

Industrial Relations and Human Relations

IN an address on January 20, 1954, to the Birmingham branch of the Institute of Personnel Management, Sir Godfrey Ince, permanent secretary to the Ministry of Labour and National Service, concluded that although we have gone a long way towards establishing good industrial relations and constitutionalism in British industry and have made great progress in good labour relations techniques, "we have not yet gone very far in tackling the problem underlying good human relations, the problem of securing the right attitude of mind in industry". The address is printed in the latest issue of the Institute's journal, which also contains an important article on joint

consultation in the electricity supply industry by R. D. V. Roberts, secretary to the National Joint Advisory Council for the Electricity Supply Industry (36, No. 327; March 1954). A report of a discussion on the value of wages as an incentive to higher production is also included.

The National Trust

THE fifty-eighth annual report of the National Trust, for the year 1952-53, gives a further warning of the importance of increased voluntary support to enable the Trust to take advantage of the new opportunities which the Historic Buildings and Ancient Monuments Act offers it. This Act embodies a good many suggestions made to the Government by the Trust, and the Council notes with particular satisfaction that the Act not only allows grants to be made from the Land Fund to acquire historic buildings but also permits annual grants for maintenance, including assistance in the case of inhabited houses in private ownership. Although the deficit of the Trust on maintenance and administration in 1952 was no more than £29,000 on an income of £355,000, and its membership rose during the year from 23,365 to 40,300, the Jubilee Fund raised in 1947 is now exhausted as well as most of the special reserves; it has been necessary to impose a temporary standstill on all but essential improvements, and only the most urgent repairs and decorations can be carried out from general funds. This naturally limits the properties which the Trust is able to accept for preservation, in the absence of provision for endowment; and a large increase in the subscription income is desirable if the Trust is to continue to carry on and expand its work.

Progress

AN excellent example of the magazines which are being produced by the larger industrial undertakings both for the information of their own employees and the enlightenment of others is shown by the present issue of *Progress*, the journal of Unilever, Ltd. (43, No. 241; 1953-54). Prof. G. J. Renier contributes a factually imaginative discourse on Anglo-Dutch amity (Unilever has strong Dutch associations), while other articles deal with places important in the Unilever economy, like the Belgian Congo and other parts of West Africa. A fascinating and unusual article on trade marks and their protection is contributed by L. A. Elwood, while other articles deal with such topics as colour in the factory and recent developments in industrial welfare in Norway. Ronald Brech explains as lucidly as possible the meaning and purpose of the bank rate, and Dr. Eric Ashby describes the need for co-operation between the universities and industry in the selection and training of potential managerial recruits. The final article shows the way in which the Department of Scientific and Industrial Research serves the community not merely through industry but more directly as a source of knowledge to make more widely known the decisions of government. The journal is produced in exquisite taste, the cover being made up of two water colours by the Belgian artist, Prof. Maurice Van Esche, who is said to be one of the few European painters who have understood and been able to interpret the character of Africa.

Manchester Public Libraries: Report for 1952-53

THE report of the City of Manchester Public Libraries Committee for the year 1952-53 (pp. 36+

8 plates) records an increase in total issues to readers from 5,937,230 to 6,241,375. This was due partly to the opening in May 1952 of the first specially designed library in Wythenshawe, already the third busiest library in the city. Of this figure, as the City Librarian notes in his report, 1,003,644 issues were to children, but books consulted in the reference libraries also increased, from 676,469 to 719,361, with an increase in readers from 555,455 to 602,528. The number of volumes in the reference libraries increased from 418,328 in 1952 to 425,484 in 1953; of these, 55,777 volumes were in the technical library, compared with 54,100. Additions to the stock of the libraries totalled 83,727, withdrawals amounting to 80,554, and the City Librarian directs attention to the effect of the increasing cost of books: while for the three years 1948-49, 1951-52 and 1952-53 the numbers of volumes purchased were respectively 92,466, 93,593 and 80,522, there being a noticeable reduction in the most recent figure, the corresponding expenditure has been £31,898, £36,331 and £36,693, the average price per book being respectively 6.80s., 7.78s. and 9.11s. Moreover, in the Reference Library the average cost is now 28.49s. and in the Technical Library 29.18s. While the book fund has slightly increased, the newspapers and periodicals fund has lagged much further behind rising costs; in 1952 this amounted to no more than £2,899, an increase of £55 since 1921, and, of fifty-eight titles of science periodicals listed by the Science Museum Library in London as not available for loan to other libraries, only eighteen were available in the Manchester Public Libraries. These rising costs obviously hamper the extension of the Technical Library service, and hope is expressed that speedy government aid will be forthcoming: "for it is within the power of the public library service of this country to provide industry with an information service which would repay handsomely any expenditure involved". During April 1952 the department acquired an 'Agoflex' copying machine which renders possible a 'while-you-wait' copying service: 5,675 items have been copied in this way, compared with 2,089 last year. Some 503 books and periodicals were loaned specially to local firms, an increase of 40 per cent on the previous year, and stress is laid on the growth of co-operation with the industrial libraries of the area, the library of the Manchester College of Technology and other local and national libraries.

New Laboratory for Oceanographic Research at Woods Hole

THE United States Navy has built a new laboratory for oceanographic research at Woods Hole, Massachusetts, and the laboratory will be formally opened on June 21. Following this, during June 22-24, the United States Office of Naval Research, in conjunction with the National Academy of Sciences and the National Research Council, will hold a three-day oceanographic convocation, in which will be presented the broad scientific significance of oceanography, its needs and its potentialities, and its relations to the constituent fields of science. The first day will be devoted to physical oceanography, the second to biology in oceanography and the third to geology, geophysics and meteorology in oceanography. Some twenty scientific workers, drawn from both the United States and abroad and representing a wide field of interests, are being invited to participate. The proceedings will afterwards be published.

Pan Indian Ocean Science Association : Congress In Perth, Western Australia

THE second science congress of the Pan Indian Ocean Science Association will be held in Perth in the University of Western Australia during August 17-24, under the presidency of Prof. H. J. Bhabha. The Association, which was formed in January 1951 at a meeting in Bangalore, exists to discuss and promote concerted action in regard to scientific problems affecting the peoples and countries around the Indian Ocean and generally to improve friendship and co-operation among them. Representatives are sent from Australia, Burma, Ceylon, France, India, Madagascar, Malaya, Netherlands and Portugal. Those attending the congress will be in one of three categories: official delegates of each participating country, the limit being ten per country; accredited members, who are nominated by the representative institution of the member country; and guests invited by the president. The work of the congress will be for the most part arranged by the seven sections of the Association: (A) physical sciences; (B) biological sciences; (C) geological sciences; (D) agricultural sciences; (E), economics, education and social sciences; (F) geography and oceanography; and (G) human ecology. During August 25-28 a number of excursions will be made, catering mainly for those concerned with the biological sciences; geology and mining; and agricultural sciences and forestry. All communications relating to the congress should be addressed to Prof. A. D. Ross, Honorary Secretary, P.I.O.S.A., 31 Ventnor Avenue, West Perth, Western Australia.

Vacuum Techniques : Symposium In the United States

A SYMPOSIUM on high vacuum, organized by the Committee on Vacuum Techniques, will be held at the Berkeley Cartaret Hotel, Asbury Park, New Jersey, during June 16-18, 1954. The papers to be read will deal with the following five topics: a panel on nomenclature and standards; new equipment and instruments; fundamental developments in vacuum technology; methods and techniques; and applications and processes. The Committee on Vacuum Techniques has been organized as a non-profit corporation, with the prime purpose of sponsoring the symposium; in addition, it hopes to further the dissemination of knowledge of high vacuum techniques and to assist in the establishment of universally acceptable nomenclature and standards. All individuals and companies interested in attending the symposium, presenting papers or participating in other activities of the Committee should write to the Committee at P.O. Box 1282, Boston, Mass.

Chemical Society : Officers

OFFICERS of the Chemical Society have been elected as follows: *President*, Prof. W. Wardlaw; *Vice-Presidents*, Sir Ian Heilbron, Sir Cyril Hinshelwood, Prof. C. K. Ingold, Dr. W. H. Mills, Sir Eric Rideal, Sir Robert Robinson, Prof. R. D. Haworth, Prof. E. L. Hirst, Prof. E. R. H. Jones, Prof. R. P. Linstead, Prof. W. H. Melville and Sir John Simonson; *Treasurer*, Mr. M. W. Perrin; *Secretaries*, Prof. H. Burton, Prof. E. D. Hughes and Dr. L. E. Sutton; *New Members of Council*, Dr. C. C. Addison, Dr. V. C. Barry, Dr. E. J. Bourne, Dr. E. A. Braude, Dr. H. M. N. H. Irving, Prof. J. M. Robertson, Prof. H. N. Rydén and Prof. H. D. Springall.

Announcements

PROF. T. H. MARSHALL, professor of social institutions in the London School of Economics and Political Science, has been appointed to the Martin White chair of sociology tenable at that School. The title of reader in education in the University of London has been conferred on Mr. A. C. F. Beales in respect of the post held by him in King's College.

THE bequests recently made to the University of Sheffield under the wills of the late Sir George Franklin, who died in 1916, and Miss Daisy Franklin, who died in 1948, will be used for the endowment of the full-time chair of medicine in the University, which will henceforth be known as the Sir George Franklin chair of medicine. Sir George Franklin was pro-chancellor and chairman of council of the University during 1905-16.

THE second annual meeting of Committee E-14 on Mass Spectrometry, of the American Society for Testing Materials, will be held during the week beginning May 24 at the Jung Hotel, New Orleans, Louisiana. Forty-six papers will be presented, covering isotopic abundance determinations, ionization potentials, solids analysis, high molecular-weight analysis, and new mass-spectrometer techniques and developments. During the week the election of new officers of the E-14 Committee will be made. Further details can be obtained from Mr. William Priestley, jun., Standard Oil Development Co., P.O. Box 121, Linden, New Jersey.

THE annual Cornell University summer laboratory course in techniques and applications of the electron microscope will be given during June 14-26 in the Laboratory of Electron Microscopy, Department of Engineering Physics, under the direction of Dr. Benjamin M. Siegel. The course is designed for research workers in academic institutions or industry who have recently entered the field of electron microscopy or who are now planning to undertake research problems involving applications of this instrument. Inquiries should be addressed to Dr. Siegel at the Department of Engineering Physics, Rockefeller Hall, Cornell University, Ithaca, New York.

THE Textile Institute is offering a Cotton Industry War Memorial Scholarship, of maximum value £950, for a three-year course in textile technology at an advanced level, with provision for industrial training and experience of a special character in Britain or overseas. The closing date for applications is April 30. The Institute is also offering a Peter Coats Scholarship, of maximum value £200, for one year of full-time study preparatory to taking up a course in textile technology at a university or college. The closing date for applications is May 31. Candidates for both these awards must be male British nationals less than twenty-four years of age. Application forms and further details can be obtained from the General Secretary, Textile Institute, 10 Blackfriars Street, Manchester 3.

THE second general assembly of the Italian Geophysical and Meteorological Society will be held in Genoa during April 23-25. The first two days will be devoted to the reading of twenty-three papers, and the final day will be reserved for the discussion of the Society's affairs and an excursion. Further information can be obtained from the Società Italiana di Geofisica e Meteorologia, via Balbi 5, Genova.

MEDICAL USES OF ATOMIC ENERGY*

RADIOACTIVE isotopes, which are produced by neutron irradiation in atomic piles, or extracted from the waste products of nuclear fission, or derived from the bombardment of targets in the cyclotron, are influencing many aspects of medical research and certain forms of treatment. Their peculiar merit is that, while undergoing exactly the same metabolism as ordinary matter, they can be traced through the body with great sensitivity, using suitable instruments, or, when larger amounts are employed, useful radiation effects can be caused in certain parts of the body.

The high sensitivity of detection of radioactive isotopes makes it possible to observe the dynamics of many physiological processes without disturbing the equilibria being measured. Radioactive iron, for example, is used for determining whether a particular type of anaemia is due to the failure of the iron to be absorbed from the diet, or to the iron being absorbed but not properly used in the haemoglobin and the red cells. More complex chemical compounds, or even organic structures, are 'labelled' with radioactive atoms and their metabolism studied. Thus, penicillin can be made containing a radioactive sulphur atom, or vitamin B₁₂ with radioactive cobalt, or blood cells with radioactive chromium. The problems studied with such labelled compounds include the formation of bones, abnormalities of salt excretion in adrenal diseases, the mechanism of conduction of impulses along nerves, the formation and repair of teeth, the function of the thyroid, and the metabolism in the body of steroid, peptide and carbohydrate molecules. In most of these fields the skilful use of radioactive isotopes yields information which could not otherwise have been obtained.

Measurements on patients are not limited to tests depending on the removing of body fluids; they can also be made *in situ* and are of much value to the surgeon in the operating theatre. In fractures of the head of the femur the question of whether the blood supply has or has not been abolished can be answered by injecting radiophosphorus a few hours before the operation and measuring its relative concentrations in the head and shaft of the bone. Radiophosphorus is also used during operations on brain tumours to indicate the extent of operation necessary. By intravenously injecting small amounts of radio-sodium solution and measuring the activity with counters placed on the skin, the velocity of the blood flow in the veins can be measured in conditions where thrombosis is likely to occur. The same method can be employed in measuring the speed of blood circulation around the whole body, or through the lungs alone. The dosages used in these investigations are so small that the irradiation received by the body during any of these tests is less than that received in ordinary X-ray examinations.

Turning to the use of radioactive isotopes in treatment, the aim is to deliver the maximum dose to the places to be destroyed with the minimum dose anywhere else. In one type of treatment the isotopes are applied externally or into body cavities. Thus, skin lesions are treated by applications of sheets of

plastic impregnated with radiophosphorus. Cancers involving the bladder lining can be treated with a solution of radiobromine contained in a distensible bag which can be inserted into the bladder. If a suitable colloid is introduced into a cavity in the body it will diffuse out only very slowly, if at all. The linings of the abdomen and of the chest may become involved with growth, causing distension of these cavities with fluid; the surface layers of such growth may be selectively irradiated by the introduction of a colloidal suspension of radioactive gold into the cavity.

Quite a different technique is to inject colloidal gold particles of appropriate size into the bloodstream, which will carry them until they are arrested in the fine capillaries of the lung. In this way it may be possible to treat cancers of the lung. Another possibility is to use the technique of cardiac catheterization, in which a fine tube is passed along the vein, through the heart and into an artery which feeds that part of the lung where a cancer has developed. Radioactive colloidal gold is thus located mainly in the region where the cancer is. If the particles are made small enough they will pass through all the lung capillaries and eventually be absorbed by the reticulo-endothelial cells, most of which are in the liver. This provides a method of irradiating the liver only, which may prove useful in treating certain types of leukaemia and cancer of the liver.

By making use of the chemical properties of the radioactive substances it is also possible to deposit the radioactive isotopes where required. The classic case is the treatment of toxic goitre merely by giving the patient a drink of water containing less than one ten-millionth of a gram of radioiodine. In some cases of cancer of the thyroid the secondary deposits can be induced to take up iodine in the same way as normal thyroid tissue. Hence, multiple deposits can be treated with radioactive iodine when they are too widespread for surgical removal.

Although the medical applications of radioactive isotopes are barely ten years old, they have already been developed for tests of the very highest value in research and of great convenience and some importance in routine clinical medicine. Their most important value lies in the clearer understanding that they are giving us of the body processes involved in health and disease, and in this type of investigation they are proving to have an increasing scope and power which is transforming many lines of medical investigation.

THE PARLIAMENTARY AND SCIENTIFIC COMMITTEE

THE annual report for 1953 of the Parliamentary and Scientific Committee* records a Parliamentary membership of 166 in 1952, while some thirteen further scientific and technical organizations were elected to membership during the year. Meetings of the general committee were addressed during the year by Sir Frank Engledow, on primary factors in

* Summary of a lecture by Dr. H. H. Pochin, being the fifth of the series of public lectures arranged by the Atomic Scientists' Association and the Department of Extra-Mural Studies of the University of London (see also *Nature* of February 27, p. 286; March 12, p. 477; March 27, p. 578; and April 3, p. 631).

* Parliamentary and Scientific Committee (an Unofficial Group of Members of both Houses of Parliament, and Representatives of certain Scientific and Technical Institutions). Annual Report, 1953. Pp. 28. (London: Parliamentary and Scientific Committee, 1954.)

African agriculture; by Mr. F. J. Curtis, on developing the managerial abilities of employees; by Mr. W. Allen, Mr. E. D. Hinchliffe and Mr. A. MacDonald, on economic benefits of a scientific factory design policy; by Sir Hubert Houldsworth and Dr. D. T. A. Townend, on coal production and utilization and the application of science thereto; by Sir John Hacking and Sir Harold Smith, on electricity and gas industries and the application of science thereto; and Dr. F. Roffey, Dr. R. F. Goldstein, Dr. R. Holroyd and Dr. M. A. Matthews introduced a discussion on the economic importance of the petrochemical industry. On June 16, 1953, it was agreed to set up a sub-committee to consider the whole question of higher technological education. The report includes the usual concise summary of representations made to the Lord President of the Council and of Parliamentary announcements relating to science and government during the year.

Addressing the Parliamentary and Scientific Committee at its annual luncheon on February 16, 1954, Dr. K. T. Compton, chairman of the Massachusetts Institute of Technology, said that technological education has been continually shaped to meet the needs of the country concerned. Civilian, as distinct from military, engineering schools were first developed in France and Germany about two centuries ago—in France, first as part of a national public-works programme under Louis XV, and then as part of an attempt to recover from the wreckage of the Revolution. In Germany, the impetus arose, first from the desire to recover from the economic destruction of the Napoleonic War, and secondly from her ambition to compete in industry and trade with Great Britain. The numerous polytechnic institutions and technical high schools thus established on the Continent of Europe were all State institutions, owing to university indifference or opposition. In the United States, the great impetus to engineering education came in the early 1860's; but in Great Britain the development of technical education was greatly influenced by the old guild traditions and laws governing apprenticeship, although Great Britain to-day has some of the world's best engineers.

Dr. Compton then directed attention to several trends which he thought were as significant in Great Britain as in the United States. First, the demand for engineers is increasing greatly and faster than the supply: the annual output of graduates from the United States engineering schools is less than half the forty thousand new engineers required. Secondly, the nature of the demands on engineers, and therefore the kind of education required to meet these demands, are changing: there is opportunity for at least some technological institutions to increase their emphasis on basic science and research, for a higher technological institution cannot just follow industrial trends but must anticipate and prepare for them. Moreover, to an increasing extent the most progressive technological institutions are providing education for many who are not planning to be professional scientific workers or engineers, but who see in these fields a good introduction to the cultural environment of to-day and a good medium for intellectual discipline. In this way higher technological education is helping to develop the industrial and social climate in which technological progress and productivity can thrive.

Stressing the importance of the factor of 'climate' and prestige within which the technologist works,

as well as the more obvious factor of his specialized competence, Dr. Compton expressed the opinion that the Government of Great Britain has been wise to support both the technological departments of the universities, through the University Grants Committee, and also the expansion of the Imperial College of Science and Technology, London. He thought that the diverse approach, through the universities and through higher technological institutions, has virtues in healthy competition, greater coverage, mutually supplementing programmes, and the general advantage of wider education, experiment and spreading of investment risks.

QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE

PART 4 of vol. 94 of the *Quarterly Journal of Microscopical Science*, issued in December 1953, was chosen as the "Centenary Number", and indeed it is a centenary worthy of commemoration. Actually the first number was published in October 1852, so that it has been in publication for just over 101 years. The first editors were Dr. Edwin Lankester and Mr. George Busk, who were active members of the Microscopical Society of London, and it started as a joint publication, the first part of the volume being the *Journal of Microscopical Science* and the second part the *Transactions* of the Society. The editors were solely responsible for the *Journal*. Each volume contained not only original contributions but also translations of foreign papers, long reviews, notes, correspondence and extracts from the proceedings of various societies whenever they dealt with microscopy. It was issued by a well-known publisher, Samuel Highley, who retired in 1855, and then it was taken over by J. and A. Churchill. It catered for biology, geology, histology and pathology—indeed, any branch of science and medicine that was served by microscopy. From the commencement a strong point was made of the provision of plates by the well-known lithographer Tuffin West, and they became one of its outstanding features.

The volumes of the first series, which finished with Vol. 8 in 1860, give the impression of being the work of amateurs. The term is not used in any derogatory sense but to imply persons who either did not use the microscope as an essential tool of their calling or, if they did, were interested in its application to other fields. The contributions lack a common aim; the unifying factor is the instrument used, with its ancillary techniques. With the "new series" a gradual change set in, and the memoirs became more and more by and for professional biologists, to whom the microscope was essential in their work. Vol. 3 of the new series contained a review of the Gregarinids with descriptions of three new species. It showed a comprehensive grasp of the subject and familiarity with the relevant literature in French and German and appeared when its author, E. Ray Lankester, was sixteen years old. After Vol. 8 N.S., the *Transactions of the Royal Microscopical Society* (a Royal Charter had been granted in 1866) were published independently. The following year, 1869, it was only the quarterly journal; at the same time, Mr. Busk left it and the young Oxford B.A., E. Ray Lankester, joined it as co-editor with his father. Two years later Dr. Lankester, a man of unbounded energy and

most varied interests, retired, and Dr. J. F. Payne, of St. Thomas's Hospital, joined as co-editor, thus maintaining the link with medical microscopy. With Vol. 16, 1876, E. Ray Lankester became chief editor, but had a varying panel of collaborators chosen from the leading biologists of the country. There followed a period of remarkable growth, which reached a peak in 1885, during which year 912 pp. of text and 62 plates appeared, and a second peak in 1894, with 904 pp. and 84 plates. The former was towards the end of a period when the microscope had greatly facilitated the study of the invertebrates. By this time the *Journal* was without equal in Great Britain and had achieved a world-wide reputation. Behind much of this work was the background of the ideas of evolution, and there grew up a sort of unity, lacking in the early years, in which each piece of morphology or embryology seemed to have a place.

The second peak was in part associated with the extended use of the microtome and the rise of vertebrate embryology, again with a distinctly evolutionary background, which occupied an increasing amount of space but not to the exclusion of the invertebrates, particularly Protozoa. During this expansion period the *Journal of Botany* and other specialist journals appeared, so that the "QJ." became more and more zoological. This tendency to restrict the scope of a publication seems to be inevitable; but it is to be hoped that it will not be carried to the extent that the *Quarterly Journal* becomes another of those journals not looked at save by workers in its own narrow field. E. Ray Lankester remained editor until Vol. 64, 1919, by which time he had contributed seventy-eight articles to it, a number of them becoming classics. He retired from active participation; but his name appeared as honorary editor until his death in 1929. Vol. 64 also marked fifty years of his editorship, and this was commemorated by Prof. G. O. Bourne in a long review of the outstanding memoirs that had appeared and the many distinguished names, both British and foreign, that had been associated with the *Journal*. He directed attention to one of the principal features of its outstanding success, the universality of its appeal, and that while it "had its specialities it has never been specialised". The new editor was Prof. E. S. Goodrich, a pupil of Lankester's at University College, London, whom he took with him when he went to the Linacre chair at Oxford. Goodrich's first contribution to the *Journal* was in 1893, and like his predecessor he was to prove a great editor and a great master of zoology. Three parts of Vol. 86, 1946, are taken up by a review of the work, largely by himself and his pupils, on the coelom, genital ducts and nephridia that had appeared in the fifty years since his initial contribution to the problem. He died shortly after he had corrected the proofs of this, and before it had appeared in print, and so ended a connexion of fifty-two years with the *Journal*, for the last twenty-five of which he had been editor.

With the death of Prof. Goodrich the ownership of the *Journal* changed hands, its publication was taken over by the Clarendon Press, and Dr. O. F. A. Pantin, who had joined the panel of collaborators in 1939, and Dr. John Baker became joint editors. A comparison between the earliest and the latest volumes is interesting, and shows that a number of similar problems are investigated. The techniques, of course, differ, for the plain microscope

is replaced by the electron and phase-contrast microscopes, etc., freeze drying and refined chemical (including staining) methods. It is essential to explore the possibilities and limitations of new techniques; but it seems to follow that the various contributions tend to lack the coherence so noticeable in the years before and after the turn of the century. It is interesting, too, in view of the present extensive use of photomicrographs, to find that this method of illustration was used for the first time, so far as has been traced, in one of the plates in the first volume of the *Quarterly Journal of Microscopical Science*.

The *Journal* is to be congratulated on its century and on the fact that it is "still going strong"; may it long continue to be the fertile source of inspiration that it has been in the past.

INORGANIC CHEMICAL KINETICS AND REACTIONS

A CHEMICAL SOCIETY symposium generally takes the form of a sort of scientific stock-taking at which progress and achievement in some chosen field are reported and the contemporary position impartially assessed. The symposium on "Inorganic Kinetics and Reactions", held at Burlington House, London, on February 4, was arranged by Dr. J. Chatt and Dr. L. E. Sutton rather to direct attention to a field of rapidly growing importance, and in his introductory remarks the president of the Society, Prof. C. K. Ingold, urged his many listeners to avail themselves of the opportunities open for British chemists to take their full share and—as he hoped—a leading part in its development.

The first paper, by Dr. H. M. N. H. Irving (Oxford), took the form of a general survey of problems and methods. After paying a tribute to Prof. Ingold for the great part he had played in raising our knowledge of the kinetics of organic reactions to such an advanced state, Dr. Irving suggested that the comparatively undeveloped state of inorganic kinetics is not due entirely to the general neglect—particularly in Britain—of inorganic chemistry as a whole, nor to the fact that inorganic reactions are often fast, for techniques for dealing with this problem are available. But while the organic chemist generally has a precise knowledge of the concentrations, compositions and detailed structures of the materials reacting in the systems he investigates, remarkably little is known in many cases concerning even the actual species which participate in an inorganic reaction such as that formally represented by the equation:



The extent to which a cation is hydrated in solution, the firmness with which the primary solvation sheath is attached, the extent and rate of ionization of hydrogen ions from an aquo-cation to form water-soluble basic species or polynuclear complexes, and the effects of complex formation with all anions present—these factors are seldom known with any accuracy, though they may be of essential significance in elucidating reaction mechanisms and kinetics in inorganic chemistry.

Techniques for measuring the rates of inorganic reactions are already numerous, though dynamic flow methods and calorimetric methods have not

yet been extensively employed. Bjerrum's effective device of working at very low temperatures (-75° to -100° C.) has already provided interesting results. Great impetus has recently been given to the field by the general availability of radioactive and stable isotopes and ancillary counting equipment and mass-spectrographs.

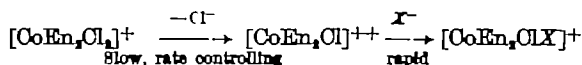
A feature common throughout inorganic kinetics is the complexity of the processes taking place. For the exchange reaction of ferrous and ferric ions the rate equation may be written:

$$R = [\text{Fe}^{\text{II}}][\text{Fe}^{\text{III}}]\{k_1 + k_2/[\text{H}^+] + k_3[\text{X}^-]\},$$

where the inverse rate-dependence on hydrogen-ion concentration shows that the (hydrated) species FeOH^{2+} is involved, while the term involving X^- ($= \text{Cl}^-, \text{NO}_3^-, \text{etc.}$) shows that ferric complexes of the type FeX^{2+} are participating. But while the kinetics can be interpreted by postulating a transition state of the type $(\text{III})\text{Fe}^{2+} \cdots \text{OH} \cdots \text{Fe}(\text{II})^{2+}$, the effective exchange of charge which appears to take place may involve (i) actual transfer of an electron from right to left, (ii) transfer of a hydroxyl group, or (iii) transfer of a proton from a water molecule attached to the ferrous ion to the hydroxyl group.

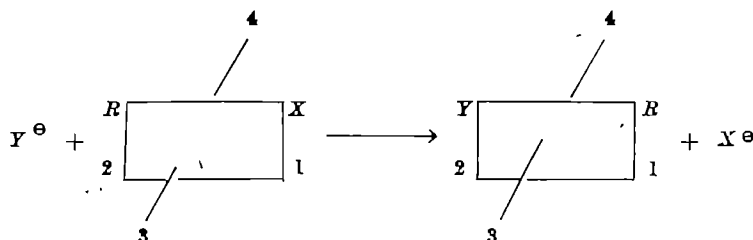
Exchange of a complex ML_n with a labelled ligand L^* may proceed either through dissociation (with or without an intermediate stage of aquation) or by an association process which involves an increase in the co-ordination number of the central atom. Examples of both types are known, and considerable progress has been made in correlating the ease of exchange with the type and strength of bonding in the complex. In organic chemistry, stereochemistry is dominated by the tetravalency of the carbon atom; but in inorganic chemistry, planar, tetrahedral and octahedral dispositions provide a variety of new problems, some of which would be dealt with in the next paper. As an illustration of the unsolved problems of inorganic mechanism, Dr. Irving concluded by quoting the reaction of $D - [\text{CoCo}_3(\text{L}, \text{pn})_2]^+$ with a 100 per cent excess of *d,l*-tartaric acid whereby the dextro-form displaces carbonate ion preferentially from the complex, thus effecting a partial resolution. Is this due to differing stabilities of the complexes containing *d*- or *l*-tartaric acid, or to different rates of reaction of the two enantiomorphs with the carbonatecobaltic ion?

Prof. O. K. Ingold (London) then spoke on the "Mechanism and Stereochemistry of Octahedral Substitution", dealing first with the kinetics of chlorine displacement from *l*-*cis*-dichlorobisethylenediaminecobalt-III by a graded series of nucleophilic reagents (X^-) such as $\text{MeO}^-, \text{N}_3^-, \text{NO}_2^-, \text{SCN}^-, \text{Br}^-, \text{Cl}^-$ and NO_3^- . Kinetics were followed by a variety of techniques such as polarimetry, spectrophotometry, titrimetry, and the use of radioactive chlorine-36. While bimolecular reactions occur with the first three reagents named, nucleophilic substitution proceeds by $\text{S}_{\text{N}}1$ mechanism with the last four. Since optical activity is completely lost, and at the same rate, in these last four cases, the following mechanism was proposed by Prof. Ingold:



The short-lived, optically inactive intermediate contains 5-covalent cobalt-III and may be formulated as a triangular bipyramid or as a square pyramid. It can take up the substituting agent at comparably rapid rates in all the distinguishable five positions in proportions which depend in detail on the groups already present, and on the nature of that entering.

Prof. Ingold pointed out that a most confusing variety of stereochemical changes among co-ordination compounds of the type CoR_4X has been reported on replacing X by Y . If these are bimolecular and proceed by edge-displacement, the type of configurational change observed depends essentially upon the atom chosen as the reference point. If this were atom 1, the edge-displacement could be described as a *cis* $\rightarrow$ *trans* change; if at 2, as *trans* $\rightarrow$ *cis*; if at 3 or 4, as either

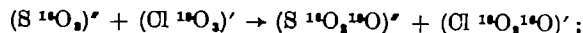


$d \rightarrow l$, or $l \rightarrow d$. Indeed, if certain geometrical conditions are satisfied, edge-displacement can proceed without apparent geometrical isomerization or change of optical configuration. In two cases the stereo course of an $\text{S}_{\text{N}}2$ change has been studied in detail, with the following results:

	OH^-	per cent <i>cis</i>	per cent <i>trans</i>
<i>trans</i> - $[\text{CoEn}_2(\text{SCN})\text{Cl}]^+$	$\rightarrow [\text{CoEn}_2(\text{SCN})(\text{OH})]^+$	72	28
<i>trans</i> - $[\text{CoEn}_2(\text{SCN})\text{Br}]^+$	$\rightarrow [\text{CoEn}_2(\text{SCN})(\text{OH})]^+$	75	25

showing that substitution in octahedral complexes proceeds predominantly, but not exclusively, by 'edge-displacement'. This result should be contrasted with $\text{S}_{\text{N}}2$ substitution among tetrahedral carbon compounds, which leads practically exclusively to optical inversion.

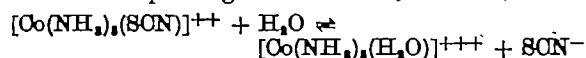
The next speaker, Prof. F. S. Dainton (Leeds), prefaced his paper entitled "Physico-chemical Mechanisms Involved in Electron Transfer" by saying that he proposed to underline some of the general remarks made by Dr. Irving. Atom transfers are certainly known, such as



and electron transfers between, for example, argon and sodium vapour are well established. But while Ti^+ and Ti^{2+} , and Fe^{2+} and Fe^{3+} give couples individually reversible at a platinum electrode so that the position of ultimate equilibrium in a mixture can be calculated from the redox potentials, these give no clue to the rate of reaction.

The fundamental principles of electron transfer reactions were then discussed by Prof. Dainton along the lines suggested by Mulliken, and by Evans and his co-workers. Vinyl compounds which are polymerized by hydrogen atoms serve as detectors for hydrogen atoms produced, for example, by photochemical electron-transfer from reducing ions, though it is always necessary to take into account possible complex formation between cations present and the

aquation background. For the first-order aquation of the corresponding cobaltammine, however,



the rate was given by $k = 0.85 \times 10^{12} \exp(-26,800/RT)$. While in this case aquation and the rate of release of thiocyanate ions was found to be catalysed by thiocyanate ions, no similar rate-enhancement was observed with the chromammine. These differences could be explained by postulating the operation of an association (S_N2) mechanism for the chromium complexes, but a dissociation (S_N1) mechanism for those of cobalt. But it should not be overlooked that the rate of exchange of water is known to be increased in many cases by increase in ionic strength, so that the catalytic effect of the thiocyanate ions might well be due to their causing an increase in ionic strength rather than to the progress of a bimolecular substitution.

The lively and prolonged discussions which followed each group of papers brought valuable contributions from a very considerable number among the audience and added greatly to the success of what was obviously an exceptionally well-appreciated, stimulating, and well-timed symposium. Since the whole of these discussions is to be reported in full by the Chemical Society in a special publication of all the papers contributed to the symposium, no attempt will be made here to indicate even their scope or quality; but they certainly suggested that the hopes expressed by the president in his opening remarks would not long await realization.

H. IRVING

UGANDA PROTECTORATE FOREST DEPARTMENT

ANNUAL REPORT FOR 1952

THE annual report of the Uganda Forest Department for the year ending December 1952* makes an outstanding departure from the forestry reports of most of the British Colonies—and, it might be added, other parts of the Commonwealth—by virtue of the noteworthy position it gives to a consideration of working plans. This important branch of forestry work is dealt with under the heading of "Enumerations and Working Plans" in Chapter 3, and follows remarks on policy and legislation in Chapter 1, the form of which remains unchanged and on the lines of the official statement made by the Governor in 1948, and data on the forest estate for the year, which are contained in Chapter 2.

A working plan for a forest is not necessarily made only when an annual financial income is assured. A chancellor of the exchequer or financial minister to a Colonial Government has to provide money in his budget for non-productive objects of indirect benefit to the community. In a similar fashion, forests may have to be managed, especially protection forests, or those which secure amenities for the public but do not make a direct financial profit. As regards financially productive forests, a working plan is necessary even though the area may be run on a short rotation for the public,

often to provide the agricultural villager with fuel. Once under a working plan sanctioned by the highest Civil authority in the country, a forest is safe in perpetuity so long as the prescriptions laid down for a short period of years are strictly carried out. A perusal of the chapter in this report devoted to this branch of forestry work shows that these premises are well understood by the Government and the Chief Conservator of Forests in Uganda. Equally interesting are the remarks on the methods upon which the enumerations of the growing stock of the forests are being undertaken; for a plan cannot be drawn up until as detailed a knowledge of the contents of the forest as possible is obtained.

Five new working plans were approved during the year, and progress was made in the compilation of a number of other plans and revisions, some being in first draft during the year. One of the sanctioned plans, the Mbele Plantations for 1953-60, is for pole and fuel plantations covering a coppice rotation; another prescribes the management of six protection central forest reserves in the northern Acholi hills; a third, the West Nile Southern Escarpment hill-tracts working plan for 1952-61, prescribes the protection and maintenance of nine local forest reserves in the West Nile. The mere names and the reasons for these working plans indicate the sound lines of work which the Chief Conservator is engaged upon.

It is all the more satisfactory and of promise for the future that working plans are in force or in preparation for local forests under African management. The area of pole or fuel plantations, twelve in number, managed by African local governments amount to 7,691 acres, of which several are already under working plans. This type of work in tropical forests involves a considerable amount of research, and the staff of the Department are to be congratulated on the amount of work which has been carried out on this account. E. P. STEBBING

CARNEGIE INSTITUTION OF WASHINGTON

ANNUAL REPORT

DR. VANNEVAR BUSH'S annual report* as president of the Carnegie Institution of Washington mentions as the most interesting of the Institution's research activities in the year ending June 30, 1953, an entirely new approach at the Mount Wilson and Palomar Observatories to the problem of the general magnetic field of the sun. Observations made possible by the greatly increased power of the new Mount Wilson gratings, and new photoelectric techniques have confirmed the existence of a general magnetic field much weaker than earlier measurements suggested and limited to the neighbourhood of the poles. Preliminary values obtained with the new Hale telescope and more advanced techniques now available indicate that a drastic revision of the distance of the Andromeda nebula and other distances dependent on it will be required: the earlier values of the distances and linear dimensions of all nebulae must be approximately doubled

* Uganda. Annual Report of the Forest Department for the Year ended 31st December, 1952. Pp. II+88. (Entebbe: Government Printer, 1953.) 1.75s.

* California Institute of Technology. Annual Report 1952-1953. Comprising the Reports of the President, the Secretary, the Comptroller, and other Administrative Officers. Pp. v+142. (Pasadena, Calif.: California Institute of Technology 1953.)

and their luminosities quadrupled. During the year a new and extremely sensitive light-measuring device in the form of a photon-counter has been developed for the Hale telescope, by which light received from an object can be measured at the extreme limit that can be photographed with the 200-in. telescope.

Improved techniques have now surmounted experimental difficulties which hampered work at the Geophysical Laboratory on rock-forming minerals mixed with volatile components, and a better understanding is being obtained of the process of formation of granite, as well as new insight into the chemistry of the micas. Apparatus is now in use which can give pressures up to 200,000 lb./sq. in. at temperatures of 1,000° C. or higher, and studies with this apparatus indicate that the solubility of solid inorganic substances in compressed gases can reach unexpected magnitudes.

In the Department of Terrestrial Magnetism, by measuring the incorporation of isotopically labelled compounds in bacterial cells, flow patterns have been obtained which account for more than 80 per cent of the carbon incorporated: this is converted from glucose to the amino-acids, purines and pyrimidines eventually used in the synthesis of protein and nucleic acid molecules. Studies of the Krebs cycle show that in *Escherichia coli* growing with glucose as the sole source of carbon, the Krebs cycle acts chiefly by synthesizing aspartic and glutamic acids, and contributes little to oxidation, although in certain circumstances the flow alters to emphasize oxidation rather than synthesis.

Studies of winds in the upper atmosphere and a revised understanding of the electrical conductivity of the ionosphere now suggest that the electrical currents which produce magnetic storm effects are primarily in the atmosphere, and the wind motions causing them are initiated by radiations and possibly by particles from the sun. In the Department of Plant Biology, the biochemical group has shown that the reversible changes in the absorption spectrum of chlorophyll in certain photosynthetic bacteria are increased when oxidizing substances are added to the bacteria and decreased in the presence of substances, such as peptone, that enter into the normal metabolism of the cells. The change, by absorption of light, of protochlorophyll to the photosynthetic pigment, chlorophyll, occurs in leaves even at -77° C., although the rate of change and its extent diminish below 0° C. Studies in the Department of Genetics of reproduction in bacteriophages have partly confirmed the view that infection of the bacterium *Escherichia coli* by bacteriophage T₂ begins with the injection of pure phage nucleic acid into the cell. The findings are consistent with an intracellular population of multiplying non-infective phage and with the idea that non-infective phage particles consist of or contain nucleic acid. Presence of a mutation-inducing factor at a particular locus in a maize chromosome results in the production of a large number of mutations affecting the action of genes on either side of it.

In the Department of Embryology, a noteworthy advance has been made in a study of the action of the blood circulation, especially of the lungs of the new-born animal just before and just after the time of its birth. Further work on the physiology of uterine muscle has shown that progesterone produces its effects on muscle tissue by altering the rate of access of potassium ions to the contractile tissue.

VARIATION WITHIN INBRED STRAINS OF MICE

By DR. H. GRÜNEBERG

University College, London

THE use of inbred strains of mice and other rodents has been widely recommended for experimental purposes. The advantage of highly inbred over ordinary mice is held to be that the members of an inbred strain are genetically very similar and hence presumably more uniform both anatomically and physiologically. As a consequence, an experiment carried out with a given number of inbred animals is expected to give a result of greater precision than if the same number of ordinary mice had been used. Moreover, an experiment carried out by A would be more accurately repeatable by B if both use the same standard inbred strain of animals than if they use batches of ordinary mice.

The confidence with which inbred strains have been recommended for general experimental use rests largely on the prestige of the mathematical theory of the results of inbreeding; or, more properly, of an early phase of that theory. For example, it can be calculated what progress towards homozygosity will be made by ten or twenty generations of brother-sister mating in the absence of selection. In practice it is, however, difficult to avoid selection in favour of the more fertile heterozygotes, and it has recently been shown¹ that a comparatively moderate advantage of the heterozygotes over the homozygotes can greatly retard and indeed completely arrest the progress towards the fixation of genes by inbreeding. Recent work in *Drosophila*² has shown that the selective advantage enjoyed by many genes and gene complexes in the heterozygous, as compared with the homozygous, state is surprisingly great; no comparable data are yet available for the mouse or other mammals. Heterozygosis in an inbred strain is also replenished by mutation and hence depends on the total spontaneous mutation-rate, for which no estimates are as yet available in the case of mammals; it may be high as compared with *Drosophila*, as was found to be the case for the induced mutation-rate in a number of selected loci in the mouse³. Taken together, residual heterozygosis and heterozygosis due to mutation constitute the irreducible heterozygosis in a pure line. Its level will be reflected in the extent to which the pure line is split up into genetically different sub-lines in the course of continued inbreeding. It is the level of this irreducible heterozygosis (rather than its source) which is of primary interest for all practical purposes.

That pure lines of mice do, in fact, split up into genetically distinguishable sub-lines in the course of continued inbreeding has become obvious in recent years through the appearance of coat colour mutations, of histo-compatibility genes and, more recently, of structural differences such as the number of pre-sacral vertebrae^{4,5}. In all these cases, changes in a single feature only have been studied, and while such facts have given qualitative evidence for sub-line development, they have not been suitable for quantitative studies of that process.

Material highly suitable for the quantitative study of variation within pure lines has become available

in recent years. It has been discovered that there exists a multitude of well-defined variations in the skeleton of the mouse⁸⁻¹², most of which had previously escaped detection. More than a score of these variants have so far been studied to a greater or lesser extent, and others remain to be sorted out. These include various features of the skull and teeth, of the vertebrae (particularly in the cervical and upper thoracic region) and of the pelvis. Few, if any, of these variants are pathological. Some are confined to a single pure line; others are found in several inbred stocks though usually in different percentages; these differences between pure lines are evidence that these entities are, to some extent, under genetic control. In most cases, normals can be distinguished from abnormals without ambiguity though the degree of abnormality is often variable. While most of these variants can thus be treated as all-or-none characters, none of those so far studied is due to the segregation of a single gene; there is evidence that many of these entities have a multifactorial background^{8,9,10}; it seems that most of these characters are examples of 'quasi-continuous' variation⁸ in the sense that they are satellite characters of continuous (metrical) variations which tend to appear whenever part of the continuous distribution crosses a particular threshold; for one case (absence of third molars), this has been directly demonstrated, the continuous variable being the size of these teeth when present. As there are thus numerous characters (few of which seem to be closely correlated with each other^{8,11}) which are each under the control of many genes, the simultaneous study of all these entities within a pure line is a very sensitive tool for the discovery of genetic differentiation between sub-lines.

In Table 1 is given the percentage incidence of eleven such variants in the three pure lines *O57BL/Gr*, *OBA/Gr* and *A/Gr*. All three lines were well-established inbred strains when first imported from the United States in 1932, and brother-sister mating has continued ever since. The *O57BL* stock consists of four sub-lines which fall sharply into two groups (1 + 2 and 3 + 4, respectively); all these trace back to a pair born in 1941; from the common ancestor of all four sub-lines to the common ancestor of 1 and 2 there are about nineteen generations, and about fifteen generations to the common ancestor of 3 and 4; the main bulk of mice in 1 and 2 are four generations from their common ancestor and those in 3 and 4 are six generations. Four out of eight variants in Table 1 which occur in the *O57BL* strain show highly significant differences between groups of sub-strains (1 + 2 as compared with 3 + 4). In another two instances, one of the two groups is split up further (1 vs. 2, and 3 vs. 4), and in one instance (not given in Table 1) there is clear evidence¹¹ for a further splitting up of families within a single sub-line. Similar evidence comes from other mouse pure lines (ref. 11 and unpublished). While much more work is needed to fill in the details, it is obvious that mouse pure lines are far less homogeneous genetically than has been commonly assumed. Nor can this situation be improved by cutting down the stock periodically to the offspring of a single pair as is customary in some laboratories; while this reduces the co-existence of genetic differences in space, it increases genetic fluctuations in time.

Apart from the genetical variation due to sub-strain formation and due to sex, the skeletal variation

Table 1. PERCENTAGE INCIDENCE OF ELEVEN SKELETAL VARIANTS IN THREE INBRED STRAINS OF MICE; FOR ONE OF THEM (*O57BL*), DATA FOR TWO GROUPS OF SUB-LINES ARE GIVEN SEPARATELY (SIGNIFICANT DIFFERENCES IN ITALICS).

The percentages refer to animals except in the variants marked with asterisks, which refer to sides of animals

Variant	Ref.	<i>O57BL/Gr</i>		<i>OBA/Gr</i>	<i>A/Gr</i>
		1 + 2	3 + 4		
Interfrontal	9, 10	54.7	78.3	86.2	11.7
Parted frontals	9, 10	1	3	83	29
Pre-anheloid					
preoptic sutures*	10	25.6	43	94.5	99.5
reduced metopias					
roots*	10	1.5	0.5	72.5	22.5
Absence of 3rd molars	6, 11	0.2		17.9	3.5
Dysmorphism of O1 and O2	6, 11	43.5	51.5		
Cervical fusions	6, 11	3.7	11-63.7	0	0
Dystopia tuberc. ant. of O6	6, 8	0	0	6.4	0
Lumbo-sacral variation, ♂♂	11	21.3	5.3	?	17.3
For. acetabuli perforans*	8	0	0	64.8	0
Dysmorphism ischio-pubis, ♀♀	8, 11	25.6	85.1	0	0
		28.6			

within a pure line of mice is mainly due to intangible factors which affect individuals within a litter (or even sides of an individual) as units and which are commonly described as accidents of development; these accounted for more than 80 per cent of the total variance in three-quarters of the characters studied¹¹. The remainder of the variance is due to environmental factors which tend to affect litters as a whole, such as litter size, parity, maternal age, gestation length and, in one instance at least (size of third molars¹²), lactation. The overall picture is thus similar to that found in previous analyses of the sources of variation in the guinea pig and in the mouse.

As mentioned above, the genetic background of most of, or all, these skeletal variants is multifactorial. As such, one might expect them to be easily influenced by changes of the (pre-natal) environment. Indeed, quite a small change in the diet of the parents (from diet 86 to diet 1 of the Rowett Research Institute) had a clearly detectable influence on a metrical character in the *A/Gr* pure line, the size of the third molars¹². A drastic change of diet (from the near-optimal diet 86 to a very unbalanced regimen of oats and a little hay) massively changed the incidence of nine out of twelve variants studied in the *O57BL/Gr* pure line (Table 2¹³). The changes were by no means all in the same direction; the incidence of some variants went up, that of others went down, while a few characters did not seem to be influenced at all. A particularly interesting case is that of dysmorphism of the second thoracic vertebra in which the spinous process is split longitudinally. This variant did not occur in the controls, but was common on the oats diet; it is found rarely (about 1 per cent) in a distant branch of the same *O57BL/Gr* sub-strain and is very common, on a normal diet, in the *O57BL-b* sub-strain maintained at the Jackson Memorial Laboratory, Bar Harbor, Maine, U.S.A. Evidently, all these branches of the *O57BL* 'family' are capable of producing this variant; in some sub-strains the feature is largely above the threshold, while in others it crosses it but rarely. But even in a sub-strain in which the variant is normally completely submerged, it can be raised above the threshold by a suitable change of diet.

Table 2. PERCENTAGE INCIDENCE OF OBTUSE VARIANTS ON TWO DIFFERENT DIETS¹

Variant	Diet 86	Oats	χ^2	P
Interfrontal	36.5	57.1	8.27	0.004
Parted frontals	3.5	20.0	6.17	0.015
Squamosal-parietal fusion	15.8	1.4	8.56	0.004
Occipital-parietal fusion	7.9	4.8	0.51	0.50
Dysmorphism of C1 and C2	51.5	51.4	0.00	0.99
Dysmorphism of Th 2	0	16.4	—	0.000

Features of the skeleton are the material of the vertebrate paleontologist and, to a large extent, of the physical anthropologist. There has been some bias in ascribing skeletal differences, particularly between human groups, to heredity rather than to factors of the environment. The facts just related are a salutary reminder that even the skeleton is far from immune from environmental influences, and a skeletal difference between two populations (whether in space or in time) may well have a purely nutritional basis. Of course, it would be absurd to suggest that long-continued trends in skeletal change can be accounted for on this basis.

The total variability of a population is commonly regarded as the sum of its genetic and environmental components. On the basis of this reasoning, it has sometimes been taken for granted that the reduction of the genetic variance by inbreeding will automatically be accompanied by a corresponding reduction of the total variance. An inbred strain (apart from sub-line formation) should thus be less variable than a genetically mixed population. This expectation based on general grounds clearly requires to be confronted with reality. This may be done by comparing the variability within pure lines with that of crosses between pure lines^{1,2}. From the data so far available, it is certain that inbred mouse strains are by no means always less variable than genetically mixed populations. On the contrary, in several cases, the pure lines are far more variable than the F_1 and even the F_2 generations derived from crosses between them. This is in agreement with recent work on *Drosophila*^{11,12}, *Primula*¹³, *Lycopersicon*¹⁷ and other organisms, and evidently means that, at least for some of the multifactorial characters here considered, the homozygous state tends to be less stable developmentally than the heterozygous condition. (This incidentally means that, in biometrical genetics, it is no longer admissible to treat the total variance as if it were the sum of the environmental and the genetic variance. That treatment implies that the two components are independent of each other, whereas it now appears that the environmental may be a function of the genetic variance.) While, in some of the cases just considered, pure line animals are more variable than heterozygotes, the situation is clearly quite different, for example, in the case of antigenic characters (histo-compatibility genes, etc.) where, in tissue transplantation experiments, the reaction of pure-line animals is vastly more uniform than that of a genetically mixed batch of mice. Similarly, in cancer research, the superiority of pure-line mice has been established beyond doubt. [See also p. 686 of this issue of *Nature*.]

Summary. There is evidence that pure lines of mice are much less homogeneous genetically than is widely believed. It also appears that, in the case of some multifactorial characters at least, the homozygous state tends to be less stable developmentally than the heterozygous one. It follows that, while

pure-line mice are superior material for certain types of experimentation, they may be inferior to genetically mixed animals for other purposes. [Jan. 1.

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RADIOCARBON AND SOME APPLICATIONS IN BIOCHEMISTRY

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FOR the biochemical investigations to be undertaken with radiocarbon in these laboratories, measuring methods of special sensitivity had to be developed. In particular, the Geiger counting of carbon dioxide gas is now carried out here as a routine method. At first, carbon dioxide at a pressure of up to 5 cm. mercury was added to the usual argon-alcohol mixture¹. Later it was found, contrary to the experience of previous authors, that Geiger counters can be operated with fillings of pure carbon dioxide². A Neher-Pickering quenching circuit is used; resolving power is small, but this does not matter as the gas-counting method is in any event used for weak samples only. The counters have a volume of about 25 c.c., and are filled to a pressure of 40 cm. mercury. The plateau is excellent (Fig. 1), and is not critically affected by water or mercury vapour. The measured activity is, of course, strictly

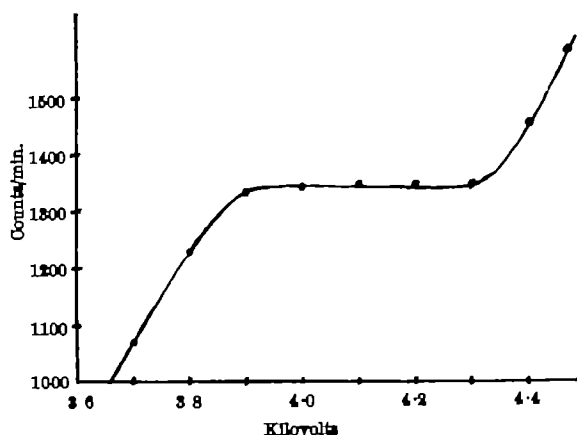


Fig. 1. Typical plateau of carbon dioxide-filled Geiger counter at a pressure of 80 cm. of mercury. (Enough counts were taken to exclude statistical fluctuations)

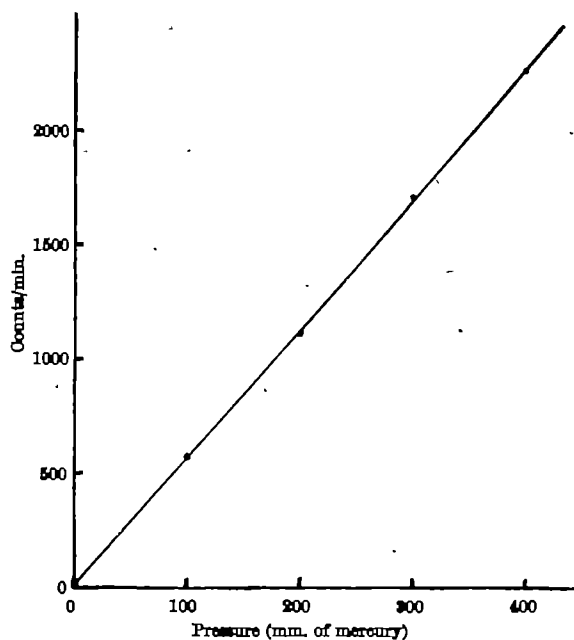


Fig. 2. Activity as a function of carbon dioxide pressure

proportional to pressure (Fig. 2). No prolonged pumping is required between the fillings, so that twenty or more samples can be measured per day. No 'memory effect' was ever observed. Numerical comparison shows that for weakly active samples of a mass of the order of a millimole, this method of measurement is probably the best⁴. In particular, it exceeds in sensitivity the determination of radio-carbon with the window counter by two orders of magnitude.

More recently, Dr. M. Reinharz, of these laboratories, has tested in Brussels, in collaboration with Dr. G. Vanderhaeghe, a photographic method for the assay of radiocarbon⁵. A solution of the active material is introduced into a glass capillary, which is embedded in an electron-sensitive nuclear emulsion by pouring the liquid emulsion over it. After a few days, the plate is developed and the beta-ray tracks are counted under the microscope. The background in this method is very low ($\sim 10^{-18}$ curie/cm. tube-length). Thus, activities can be measured smaller than those measurable with any other method by a factor of at least 10^3 . The volume of the capillary being minute ($\sim 3 \times 10^{-8}$ c.c./cm.), the method is useful mainly for very small samples. Such samples occur in the analysis of chemical fractions from small organs of animal or plant origin. The method will be suitable for measuring the activities of individual cells.

The gas Geiger counter has been used to re-determine the capture cross-section of the carbon-13 isotope for thermal neutrons⁶. It has been found that this cross-section is at least ten times smaller than was believed previously, and cannot much exceed that of carbon-12. It follows, then, that the major part of neutron capture in natural carbon is due to carbon-12, which is eighty-nine times more abundant than carbon-13.

One of our main problems in biochemistry is that of the metabolism of individual tissue cultures of animal origin. Owing to the smallness of the masses of these cultures (dry weight of the order of 0.01 mgm.), very little is known about this metabolism.

In collaboration with Dr. L. Stokinger and his group, of the Histological Institute of the University of Vienna, we have fed these minute tissue cultures radio-glucose and -fructose of exceedingly high specific activity. After the usual incubation period of two days, weighable quantities of suitable carriers, for example, fats or amino-acids, are mixed with the cultures, chemical separations are performed, the individual fractions obtained are subjected to combustion, and their activities measured. These activities indicate how much sugar the tissue had converted into the fractions. Very careful tests were carried out to exclude spurious activity due to adsorption⁷.

It has been found that individual cultures of connective tissue take up in two days around 2×10^{-6} gm. of sugar each, corresponding to about 0.2 per cent of their own weights. About one-half of the activity recovered in metabolites appears as that of the end-product of respiration, namely, carbon dioxide. The activities of the following fractions have also been measured: free amino-acids + bases, proteins (after hydrolysis), lipoids, carbonic acids⁸. These fractions are being sub-divided.

It is intended to compare by this method the metabolisms of normal and cancerous cultures of similar origin. Using for such studies tissue cultures, the metabolism of uniform ('pure') tissue and not that of an ill-defined complex mixture of different tissues (as in the case of experiments with whole animals, or even tissue slices) is observed.

The very active sugars supplied to the cultures have been prepared by photosynthesis^{9,10}. Radio-active carbon dioxide is assimilated by green leaves, and the sugars are extracted. To gain specific activity, a leaf of small mass (dry weight c. 6 mgm.) is induced to take up as much radioactive carbon dioxide as possible. No carrier is used in the extrac-

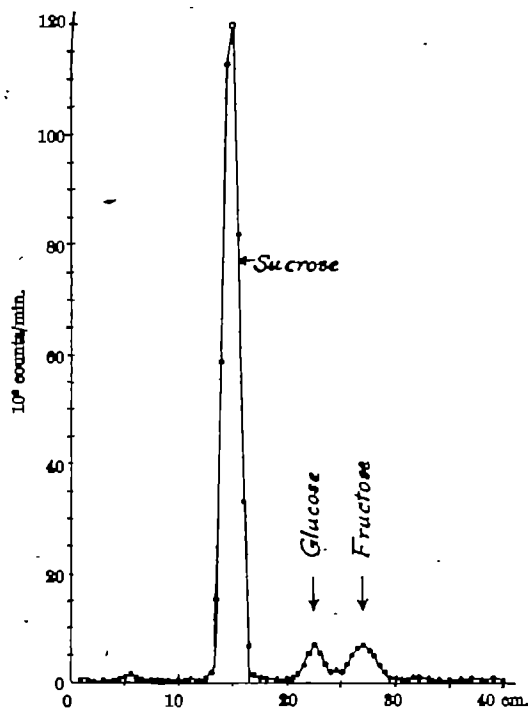


Fig. 3. Typical radiochromatogram on paper after passage of the solution through the ion exchanger (butyl alcohol-acetic acid-water)

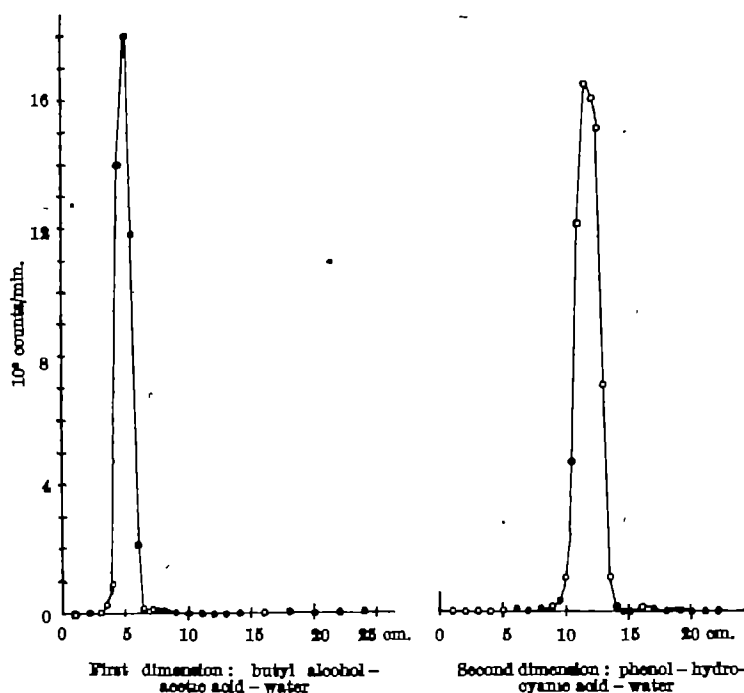


Fig. 4. Paper radiochromatogram of the sucrose eluted from the chromatogram shown in Fig. 3

tion. Naturally, precipitation reactions are excluded, as the total yield of sugar is less than 1 mgm. The sugars remain in the liquid phase, and are separated and purified by ion exchange and paper chromatography. The purity of the sugars (Figs. 3 and 4) is very satisfactory. Specific activity, starting from carbon dioxide containing 12 per cent carbon-14 dioxide, is up to 135 $\mu\text{C./mgm.}$, corresponding to $\sim 3 \times 10^{11}$ disintegrations per gm. and per min. Using the gas counter, 3×10^{-11} gm. of this sugar, or the equivalent amount of its metabolites, can still be measured with reasonable precision.

Biosynthesis has also been used for making radioactive tobacco mosaic virus¹⁰. In the first experiments, the virus was made by exposing to radioactive carbon dioxide leaves which had been infected four months previously. Yields of virus—purified by repeated isoelectric precipitation, and tested by electrophoresis—were mostly around 0.1 per cent, referred to the weight of the fresh leaf. The specific activity of the virus was of the order of 0.1 per cent of that of the carbon dioxide used. The fact that the virus showed radioactivity indicates either that growth of the virus is still going on after this long period, or that the virus, at stationary concentration, still takes part in metabolism.

In a further set of experiments¹¹, the radioactive carbon dioxide has been offered to rapidly growing virus a few days after infection. It has been found that in a certain time interval the specific activity of the virus is independent of the 'age', that is, the time since infection, while the total activity increases with age. Both the specific activity and the total activity of 'young' virus exceed considerably that of 'old' virus in that interval.

Our colleague, Prof. O. Hromatka, has synthesized butter yellow (dimethyl amino-azobenzene) from radioaniline and inactive dimethyl aniline¹². The

material is being used by us jointly with Drs. W. Zischka and K. Karrer, of the Institute of Pathology of the University of Vienna, for determining the metabolism of this compound, which produces liver cancer in rats. After oral application of 3 mgm. in olive oil in a single dose, by probe, it is found that a fair amount of radiocarbon is absorbed by the liver, but is excreted again with surprising speed, that is, within some weeks.

O. Hromatka has also demonstrated, in a different study, that *Acetobacter* incorporates carbon from radioactive carbon dioxide during submerged vinegar fermentation. On the other hand, the acetic acid produced shows very faint radioactivity only. Possibly the active acid originates in a biochemical process different from the predominating process, that is, from the process of direct oxidation of alcohol¹³.

Finally, Dr. K. Kratal has shown in experiments on the biogenesis of lignin that growing plants (beans, spruce) incorporate radioactive coniferin. The coniferin was either implanted into the cambium or introduced through the roots. The absorption has been proved both by Geiger counting¹⁴ and by radioautography. The coniferin has been made^{15,16} either from radioactive carbon dioxide by a Grignard type process or from active malonic ester, and is labelled in the 3- or 2-position, respectively. The findings lend support to the idea, put forward a long time ago, that coniferin is one of the main structural units of lignin.

Similar experiments are in progress with radioactive syringin and the glucoside of radioactive *p*-oxy-coumaric alcohol¹⁶. Along with coniferin, these glucosides are believed to be precursors of the lignins of angiosperm and especially of monocotyledonous plants.

Our work has been generously supported by the Österreichische Akademie der Wissenschaften, the Österreichische Krebsgesellschaft (Sonnleithner-Stiftung), the Österreichische Stickstoffwerke, Linz; the Österreichische Tabak-Regie, and by the Van t'Hoff Fund, Amsterdam. We also wish to thank Prof. E. Schmid, and especially Prof. L. Ebert, without whose constant active interest and help little of the work could have been done.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Effect of Molecular Weight on the Cross-linking of Siloxanes by High-energy Radiation

RECENT work has shown that many long-chain polymers^{1,2} can be cross-linked by high-energy radiation; although polymers containing only carbon atoms in the main chain have been studied in great detail, the same effect has been observed in polymers in which the main chain comprises alternating carbon and oxygen atoms ('Carbowax') or silicon and oxygen (silicones). There is a considerable amount of evidence to show that for a given polymer the density of cross-linking (that is, the proportion of monomer units which are linked) is directly proportional to the radiation dose over a wide range. This renders it possible to prepare a series of samples of known (relative) densities of cross-linking. Absolute values of the density of cross-linking may be evaluated in a number of ways, including swelling measurements and determination of the minimum radiation needed to form an insoluble network or gel in a polymer of known average molecular weight.

Conversely, measurements on irradiated polymers may be used to study their average molecular weight and weight distribution. It may be shown theoretically that gel formation first occurs when there is present on the average one cross-link per 'weight average' molecule, while the subsequent shape of the gel fraction/cross-linking density curve is directly related to the molecular-weight distribution in the original polymer. If the cross-linking density is proportional to radiation dose but is independent of molecular weight (apart from very small end-effects) the radiation dose, R , needed to promote incipient gel formation in a number of polymers of similar structure should be inversely proportional to their weight average molecular weight, M .

Lawton, Bueche and Balwit³ have found that in a number of polyethylene samples of varying molecular weights the radiation dose required for gel formation varies inversely as the 1.26 power of molecular weight, as against the value of 1 required by the above considerations. This would indicate that the density of cross-linking depends on molecular weight, even for long polymers. From the published data it is not clear that the molecular weights referred to are indeed the weight averages, and the results might be taken to show that the molecular weight distribution is different in the various polyethylenes studied. There is, indeed, some evidence that this is the case⁴.

A much wider range of molecular weights can be studied in polysiloxanes, which are available as

fluids of varying viscosities. The relation between viscosity and molecular weight has been studied by Barry⁴. It is therefore possible to study quantitatively the cross-linking efficiency (that is, the percentage of monomers cross-linked per unit radiation) as a function of molecular weight of these polymers.

Samples of polydimethylsiloxanes of various viscosities were irradiated in evacuated silica phials or in small aluminium cans, in similar positions in the B.E.P.O. atomic pile at Harwell, or in test-tubes at fixed distances from a radioactive cobalt-60 source of pure gamma-radiation, the radiation dose being proportional to exposure time. The minimum radiation dose needed to prevent melting at temperatures of up to about 200° C. was recorded; the transition from a fluid at 20° C. to one which is infusible even at these much higher temperatures is usually very sharp. Solubility measurements confirm that this change corresponds to the incipient formation of a gel structure.

The accompanying table summarizes the results obtained on a range of polydimethylsiloxane fluids. The viscosity η is given in centistokes at 25° C., and the corresponding average molecular weights M are obtained from smoothed curves of data given by Barry⁴, while M' are average molecular weights calculated from a formula of Barry: $\log \eta = 1 + 0.0123 M'^{1/2}$. Two values of R are given for each fluid; the lower value corresponds to a dose when the irradiated sample is still fluid, and the latter when gel formation has proceeded to a sufficient extent for an infusible material to result. The radiation dose for incipient gel formation lies between these values.

It is seen that over the range of molecular weights 2,000 to 115×10^3 , the product RM is constant to within experimental error, indicating that the radiation dose needed to produce an average of one cross-link per weight average molecule is inversely proportional to the number of units in the molecule. Hence the radiation required to cross-link a given proportion of the monomer units is independent of molecular length. Only for very short molecules, comprising but a few monomer units ($M < 0.12 \times 10^4$), does RM increase. This increase is not ascribed to end-effects, since it is not progressive; it probably arises from different production methods resulting in the presence of cyclic structures and a different molecular weight distribution. The published data show that for the higher polymers there is no great difference between number and weight-average molecular weight. For these polymers, unit pile radiation results in 2.3 cross-links per hundred monomer units, independent of the molecular weight. When account is taken of the relative weights per monomer (which determine in part the energy absorbed in the pile), this value is not very different from that deduced for polyethylene and similar saturated hydrocarbons cross-linked by pile radiation.

Table 1. MINIMUM RADIATION DOSE (PILE RADIATION)* FOR GEL FORMATION

Viscosity at 25° C. (η)	2×10^3	10^4	12.5×10^4	10^5	500	200	100	50	20	10	5	3
Molecular weight: (smoothed data), $M \times 10^{-4}$ (calculated), $M' \times 10^{-4}$	11.5 13.3	10.5 10.6	7 6.35	2.8 2.66	2 1.92	1.05 1.13	0.62 0.66	0.33 0.33	0.2 0.23	0.12 0.12	0.07 0.07	0.05 0.05
Radiation dose (R) (pile units)	0.025 0.03	0.03 0.035	0.05 0.055	0.10 0.11	0.15 0.17	0.3 0.33	0.53 0.58	0.8 0.81	1.85 1.92	4.6 5.3	8.5 9.5	9.9 11.4
$RM \times 10^{-4}$	23.8 34.5	31.5 36.7	35 37.5	28 30.6	30 34	31.5 33.6	33.9 36.0	30.4 30.8	37 33.4	58 64	60 67	49.5 57

* Unit pile radiation is an exposure corresponding to 10^{17} slow neutrons/cm.², plus the associated fast neutrons and gamma-rays.

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Jan. 4.

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Some Effects of Irradiation on Nylon and Polyethylene Terephthalate

In a detailed paper by Charlesby¹ on the effects of irradiation on polyethylene, he suggested that the main effect was 'cross-linking', that is, the formation of covalent bridges between neighbouring molecular chains, with the consequent loss of hydrogen. Since then, there has been a tendency to refer to the effect on any polymer as 'cross-linking' when low irradiation doses show changed solubilities in normal solvents, increased melting points, and no gross chemical breakdown², although other possible causes for these changes have been suggested³. It seems appropriate, therefore, to describe experiments on two of the polymers which have been specifically mentioned by Charlesby and Lawton, 66 nylon and 'Terylene'.

66 Nylon. Specimens of oriented 66 nylon were irradiated in B.E.P.O. with a dose of approximately 5×10^{18} n./cm.², together with the associated γ -radiation. This was fifty times the dose which first affected its solubility. Observations were that hydrogen was evolved as a gas at a rate which decreased as the dose increased. Groups of atoms were broken off and formed low-molecular weight compounds which could be extracted. On X-ray diffraction photographs of an oriented specimen, the crystallites (possibly 50 per cent of the whole) appeared to be unaffected. The strength of the irradiated material was lower than the original; but subsequent experiments have shown that complete loss of strength did not occur until after an irradiation dose sufficiently high to disrupt the crystallites.

On swelling in formic acid, diffraction photographs of the highly swollen nylon showed that the crystallites had entirely disappeared, so that the nylon together with formic acid could either have been a two-phase system, or else the nylon molecules were held together with a few loose covalent bridges. On washing with water and drying, new unoriented crystallites were formed. The degree of crystallinity was less (about 30 per cent possibly), while the intensities and spacings of the diffraction rings were consistent with the new crystallites being methyl-substituted nylon. This unoriented nylon could be oriented by stretching the specimen by an amount similar to that required to draw normal unoriented nylon. On putting the irradiated nylon, which was already highly swollen in formic acid, in a mixture of formic acid with a few per cent of hydrochloric acid, immediate solution took place (under these conditions neither peptide bonds nor $-\text{CH}_2-\text{CH}_2-$ bonds would be broken). After reprecipitation in water, the polymer had the same properties, and on casting a film rather less than 200 Å. in thickness for examination in the electron microscope, it was found

that the densities of the crystalline and non-crystalline regions were practically the same—as would be expected for an alkyl-substituted polyamide.

On irradiation of 66 nylon in the presence of air, there was a rapid loss of strength, and an analysis by British Nylon Spinners, Ltd., showed a very considerable increase in $-\text{COOH}$ end-groups (private communication).

Polyethylene terephthalate. The behaviour of polyethylene terephthalate (or 'Terylene') is completely different. To begin with, hydrogen and other gases are not evolved in appreciable quantities. Specimens of polymer chips and fibre were irradiated with approximately 1.5×10^{18} n./cm.². After this dose the fibres had completely lost their strength and begun to powder, while the chips were brittle. In specimens which were originally well crystalline the diffraction patterns looked much the same. This may be contrasted with the behaviour of 66 nylon. One polymer specimen was irradiated which had been prepared in an almost completely non-crystalline condition, and after irradiation the chips were still non-crystalline. They were then annealed at 140° C. for 1 hr., after which X-ray diffraction showed the pattern of normal well-ordered polyethylene terephthalate. This suggests (a) that extensive bridge formation could not have occurred, since any such tight linkage would inhibit the movement of molecules relative to one another, and (b) that a large number of side-groupings did not occur, since they would have shown in the diffraction pattern. The results are consistent with a straightforward breakdown of the polyethylene terephthalate chains, the breakdown products having sufficient rigidity to maintain their original positions to a fairly large extent.

End-group analyses by Imperial Chemical Industries, Ltd. (private communication), have shown an interesting difference, according to whether irradiation breakdown took place in the presence or absence of air. In the absence of air, there is a large increase in the number of $-\text{COOH}$ end-groups, whereas in the presence of a plentiful supply of air the extra end-groups were found to be $-\text{OH}$ and $\text{C}=\text{O}$, as in an aromatic aldehyde or ketone. This suggests that the molecular chains break in different places in the two cases.

I wish to thank British Nylon Spinners, Ltd., and Imperial Chemical Industries, Ltd., for providing samples of polymers.

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High-energy Microturbulence in the Solar Photosphere

THE Balmer, Paschen and Brackett lines of hydrogen in the solar spectrum are much wider than they should be according to computations based on the classical widening mechanism of the hydrogen lines¹—the statistical Stark effect of the ions surrounding the emitting atoms. The amount of widening is

greater for the Paschen than for the Balmer lines; it is greatest for the Brackett lines. It seems impossible to ascribe this widening to atomic processes, since Jürgens¹ has shown in elegant laboratory experiments that the profile of $H\beta$ is explained by the statistical Stark effect of the ions. Hence, the abnormal widening of the hydrogen lines must be explained by a mechanism which is active in the solar photosphere but not in laboratory experiments. It is difficult to ascribe it to super-excitation since the wings of the hydrogen lines are formed in rather deep parts of the solar photosphere, where deviations from thermodynamical equilibrium are not very likely to occur. It can be shown that the widening is probably explained by the microturbulence of the solar photosphere, a mechanism suggested to me by Prof. A. Unsöld, of Kiel.

Computations of the profiles of the hydrogen lines have been made for two turbulent models of the photosphere. In the first, the solar photosphere is supposed to be composed of many thin vertical columns, all with the same base areas. They are evenly distributed over the solar surface, and half of them have high temperatures, the others have low temperatures. One ray of light passes through only one column, although the spectrum is made up from the composite effect of all these columns. At an optical depth τ the temperatures in these columns are given by

$$\begin{aligned}\theta_1(\tau) &= \theta_s(\tau) + \Delta\theta \\ \theta_2(\tau) &= \theta_s(\tau) - \Delta\theta \quad (0 = 5,040/T (^{\circ}\text{K})).\end{aligned}$$

The function $\theta_s(\tau)$ is for a non-turbulent model—my model VII (*l.c.*, ref. 1). We have adopted the same relation between τ , P_s and P_e as in model VII. It is provisionally assumed that $\Delta\theta$ does not vary with depth.

The profiles of the wings of four Balmer lines, seven Paschen lines, and six Brackett lines have been computed for the centre of the solar disk for this turbulent model, and for four values of $\Delta\theta$; after that a comparison of the computed profiles with the observed ones gives by interpolation an empirical determination of $\Delta\theta$. We obtain $\Delta\theta$ values ranging between about 0.05 and 0.15, but the values seem to depend slightly on the depth of formation in the solar atmosphere. Since for each point on a line profile a 'mean optical depth of formation' can be computed, we may plot the empirical $\Delta\theta$ values against the

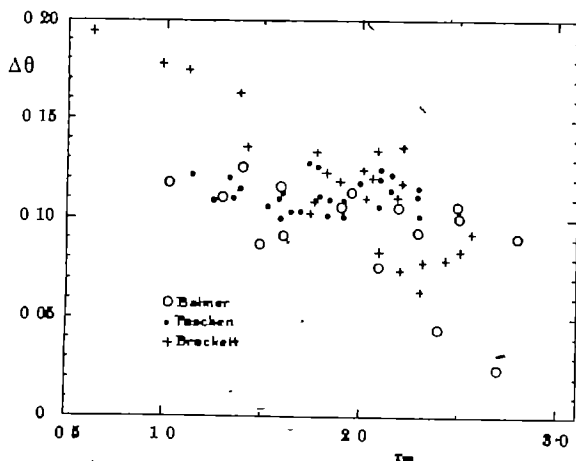


Fig. 1

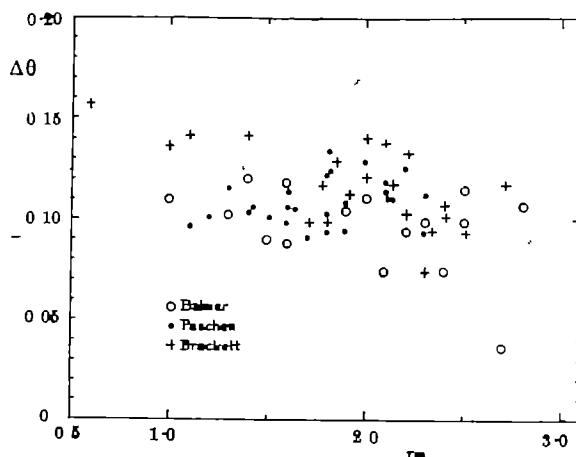


Fig. 2

corresponding mean τ -values (τ_m) in order to check whether $\Delta\theta$ varies with depth. The results are shown in Fig. 1, where τ is the monochromatic optical depth for 5000 Å. It seems that $\Delta\theta$ decreases slightly with increasing τ_m .

In the second turbulent model, it is assumed that the solar photosphere consists of many small volume elements, half of them with $\theta_1(\tau)$, the others with $\theta_2(\tau)$, distributed at random. One ray of light passes through many elements of both kinds. Here again we have adopted the same relation between τ , P_s and P_e as in model VII. The computations proceeded in an analogous way as for the first model, and the resulting $\Delta\theta$ values, plotted against τ_m , are given in Fig. 2. Here also it seems that $\Delta\theta$ depends on τ_m , but the dependence is less clear than in Fig. 1.

Both graphs show the same general aspect. It is gratifying to notice that there are no systematic differences between the points which result from the three hydrogen series. The scatter of the points is of the order of ± 0.015 in $\Delta\theta$. This corresponds with errors in the computed line profiles of ± 2 per cent (expressed in the intensity of the continuous spectrum). Since this latter value is about equal to the photometric errors in the observed line profiles, it is concluded that microturbulence is probably responsible for the additional widening of the solar hydrogen lines.

The main result of this investigation is that the temperature fluctuations in the solar photosphere are of the order of $\Delta\theta = \pm 0.1$ between $\tau = 1$ and 2.5. At $\tau = 1$, $T = 6,500^{\circ}$, giving $\Delta T = \pm 850^{\circ}$; and at $\tau = 2.5$, $T = 7,200^{\circ}$ and $\Delta T = \pm 1,000^{\circ}$. It has already been suggested by me² that the difficulties in establishing a model of the chromosphere could be solved by a 'two-temperature model'. We now find that this is probably also the case for the photosphere.

If the very great temperature fluctuations found here are confirmed by computations based on other Fraunhofer lines and on the continuous spectrum, it will be necessary to modify greatly present views on the structure of the solar photosphere.

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¹ Jager, C. de, *Recherches Observ. Utrecht*, 18, No. 1 (1952)
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Magneto-Resistance of Copper to 150,000 Oersted at 4.2° K.

SOME aspects of the theory of magneto-resistance in metals can best be tested in very high magnetic fields at low temperatures¹. We are therefore extending magneto-resistance measurements at helium temperatures to field-strengths of approximately 150,000 oersted. Such fields can only be produced at reasonable cost by employing Kapitza's technique² of short field pulses. De Haas and Westerdijk³ have shown that much improved efficiency results from cooling the magnet coil in liquid helium or hydrogen, and this has been discussed in detail by one of us⁴.

In our experiments the specimen was mounted inside a small solenoid immersed in liquid helium. The discharge of a bank of condensers through the solenoid produced magnetic fields up to 160,000 oersted for about one millisecond. The current in the solenoid, and the voltage generated across the specimen by an alternating measuring current of frequency about 10 kc./s., were presented on the screen of a double-beam oscillograph.

Fig. 1 shows the resistance change $\Delta R/R$ for commercial copper wire of diameter 0.1 mm.; residual resistance $R_{20}/R_{100} = 0.89$ per cent. One specimen was wound helically to be exposed to a transverse field. The other was placed mainly parallel to the field with approximately 15 per cent of its length at right angles to it. The error due to skin effect is less than a half per cent.

Grüneisen and Adenstedt⁵ have made measurements on a single-crystal specimen of copper of approximately ten times lower residual resistance in fields up to 12,000 oersted. Our transverse results are consistent within about 30 per cent with their measurements in the direction of greatest change of resistance if Kohler's rule that $\Delta R/R$ is a function of (H/R) is correct. No comparable data are available for the longitudinal case. Our results thus provide a

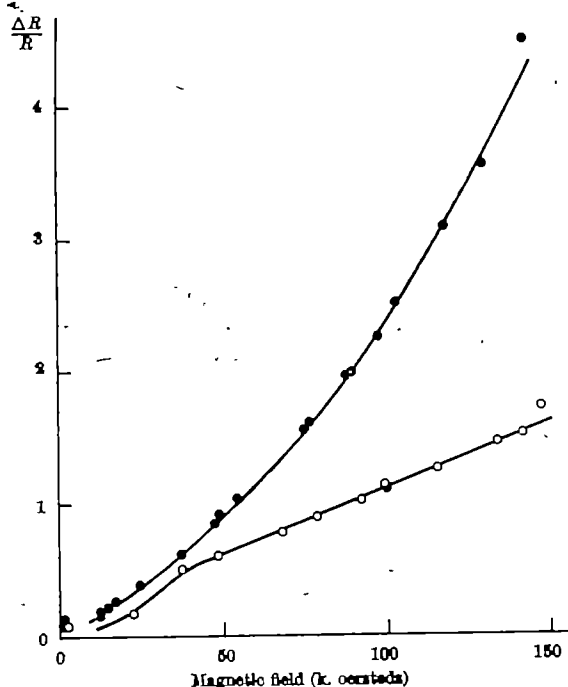


Fig. 1. Variation of electrical resistance with magnetic field in copper at 4.2° K. O — O, longitudinal field; ● — ●, transverse field

test of Kohler's rule in a region of magnetic field where there have hitherto been no measurements.

We are grateful to Prof. P. Grassmann for his encouragement and interest.

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Anomalous Temperature Coefficient of Permittivity in Barium Titanate

WHILE engaged in tests on the 'ageing' of the permittivity of a sample of ceramic barium titanate, an observation was made which may be of interest in connexion with the theory of this substance. The sample was held at a temperature of 125° C., about 1° below the Curie point through which the sample had just been cooled. It was found that the temperature cycling due to the operation of the thermostat caused the capacitance of the sample to cycle in the opposite sense, that is, a negative temperature coefficient was observed, whereas the normal permittivity curve has, of course, a high positive slope just below the Curie point. A phase lag between the switching of the thermostat and the sample temperature was at first suspected; but a test made with a thermocouple clamped to the specimen and the on-off cycle very much slowed down gave the same result.

It is well known from X-ray diffraction work^{1,2} that for a few degrees near the Curie temperature the cubic and tetragonal phases of barium titanate can co-exist in the same crystal. It now appears that a quite finite increment in temperature is needed to change the proportions of cubic and tetragonal material, for the effect described is easily explained by postulating that this ratio remains constant during the small temperature fluctuations (0.1° C.) due to the thermostat. The relatively high negative temperature coefficient of the cubic phase swamps the positive temperature coefficient of the tetragonal phase, so that a negative coefficient of capacitance is observed. An order-of-magnitude calculation shows the plausibility of this explanation. The measured permittivity of the sample at 125° C. was 4,100, while the permittivity of the cubic phase at this temperature and its temperature coefficient would be 6,600 and - 5 per cent per deg. C., as obtained by extrapolation of the Curie-Weiss law which holds above the Curie point. Values for the tetragonal phase are more difficult to extrapolate since no empirical law has been found for the part of the curve just below the Curie point. By continuing the slight upward curvature found between 105° and 118°, a permittivity of 2,200 and a temperature coefficient of + 8.5 per cent per deg. C. has been estimated for 125° C. Using the logarithmic mixture law, it is found that 55 per cent cubic phase and 45 per cent tetragonal phase will give the correct resultant permittivity of 4,100. The resultant temperature coefficient calculated with these proportions

is then - 1 per cent per deg. C. The value found experimentally was about - 1.4 per cent per deg. C.

The question of whether the transition at around 120° C. is of the first or second order was still open recently³, although several papers have now appeared reporting in favour of a first-order transition^{4,5}. The finite temperature change (of very roughly 0.3 deg. C.) which we found necessary to cause the transition to occur may be interpreted as a further argument in favour of a first-order transition; for temperature hysteresis due to the need to activate the system over a free energy barrier is a well-known feature of first-order transitions.

It may be argued that internal strains of the ceramic are causing the observed effect, which may be likened to a mechanical yield-point phenomenon. Nevertheless, any explanation based on a second-order transition would be difficult, since the structure would be changing continuously and so the permittivity should also change continuously.

It should be mentioned that the barium titanate used was particularly pure⁶. The sample had been fired in a uniform temperature enclosure and cooled slowly from the firing temperature to minimize internal strains.

Thanks are due to British Dielectric Research, Ltd., for permission to publish this note.

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Pore-Size Distribution of Porous Iron

Ritter and Drake¹ have proved the usefulness of measuring the penetration of mercury under pressure, in order to elucidate the pore-size distribution of various substances. From elementary theory, it follows that for the radius r_p of pores filled at a pressure p :

$$r_p = \frac{-2\sigma \cos \theta}{p}, \quad (1)$$

where σ is surface tension and θ is contact angle. Substitution of $\sigma = 480$ dyne/cm. and $\theta = 140^\circ$ gives:

$$r_p = \frac{75,000}{p} \text{ A. (p in atm.)}$$

Thus, measuring up to pressures of about 1,000 atm., the method is especially suited for the determination of the distribution of pore sizes greater than 100 A. In this range other methods, based on the application of the Kelvin equation to gas adsorption and desorption data, present many difficulties².

Two different samples of porous iron were used in the present study. The first consisted of tablets (diameter, 5 mm.; height, 4 mm.), pressed from carbonyl-iron powder; the particle-size distribution of the powder, determined microscopically, is given in Table 1.

Table 1

Range (μ)	Per cent (by weight)
0-1	2
1-2	4
2-3	7
3-4	9
4-5	14
5-6	19
6-7	26
7-8	16
8-9	5
9-10	3
>10	1

The second sample was obtained by reduction of a doubly promoted iron catalyst for ammonia synthesis. The catalyst contained 3 per cent of aluminium oxide and 1 per cent of potassium oxide before the reduction. The reduction was performed in a stream of pure hydrogen for 70 hr. at 450° C. As mercury shows a tendency to wet the surface of a freshly reduced iron catalyst, the sample was made passive in a stream of hydrogen containing about 0.1 per cent oxygen³ for 48 hr. at room temperature.

The total pore-volume of both samples was calculated from the difference of specific volumes in helium and mercury. The surface areas were determined from the adsorption isotherm of nitrogen at - 196° C., following the Brunauer-Emmett-Teller method for the evaluation of the monolayer capacity (for the molecular area of nitrogen 16.2 A.² was used). The results are given in Table 2 (cols. 1 and 2).

Table 2

	1	Surface area (m. ² /gm.)		5	6	
	Pore volume cm. ³ /gm.	2	3	$\bar{r}_p = \frac{2V}{F}$	r_{max}	
		B.-E.-T.		A.	A	
			Calculated from pore-size distribution	Calculated from particle-size distribution		
Carbonyl iron	0.061	0.21	0.15	0.18	5000	8000
Iron catalyst	0.116	13.1	15.1	—	177	120

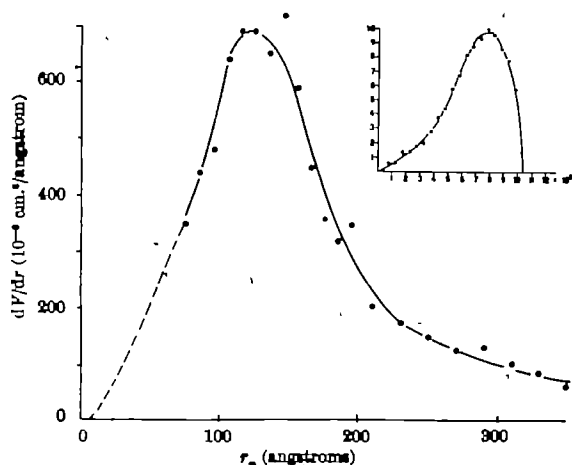
The mercury penetration was measured in an apparatus as described by Ritter and Drake¹. The maximum pressure obtainable was 1,100 atm. From a plot of the mercury-filled volume versus pore-radius, it appeared that the total pore volume of the carbonyl-iron tablets was completely filled at a pressure corresponding to a pore-radius of about 1000 A. In the case of the iron catalyst, however, about 10 per cent of the pore volume remains empty at the highest pressure obtainable. The distribution

curves, $\frac{dV}{dr}(r)$, given in the accompanying figure, were calculated by graphical differentiation of the experimental curves.

To check the results, the surface area (F) was calculated from the distribution curves with the help of the formula:

$$F = \int_0^{\infty} \left(\frac{dF}{dr} \right) dr = \int_0^{\infty} \frac{2}{r} \left(\frac{dV}{dr} \right) dr.$$

The values found are given in Table 2, col. 3, and compare well with the Brunauer-Emmett-Teller values calculated from gas adsorption data and, for the carbonyl-iron, also with the value calculated



Pore-size distribution of an iron catalyst; inset: pore-size distribution of carbonyl-iron tablets

from the particle-size distribution (from microscopic inspection the particles appeared to be spherical).

Col. 5 of Table 2 gives the values of the mean pore-radii calculated in the usual manner by dividing twice the pore volume by the Brunauer-Emmett-Teller surface area ($\bar{r}_p = 2V/F$). These values deviate from the pore radius at the maxima of the distribution curves (col. 6), which is due to the non-symmetrical form of the distribution curves.

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Influence of Electronic Impact on the Rate of Sorption of Gases on to Getter Materials

THE observations by Reimann¹ and Lukirski and Ptitsyn² showed that the low rates at which some gases (carbon monoxide, nitrogen and hydrogen) are sorbed by magnesium getters can be increased considerably if the gas molecules are converted into other particles (for example, atoms or ions) by the impact of electrons. The view that this phenomenon is a general one, also existing with other getter and gas combinations, has been supported by some experimental evidence. Haase³, for example, who was the first to use a Knudsen gauge for investigation of getters, observed that barium getters only sorbed gas at pressures between 10^{-3} and 10^{-4} mm. mercury if the getter deposit was prepared with extreme care from barium distilled *in vacuo* three times and afterwards evaporated at the very low pressure of 10^{-6} mm. Even under these stringent conditions, the gettering-rates obtained were of the order of only 10 cm.³/sec. for a getter area of 120 cm.². This result appeared to show that gettering-rates of the order of 1,000 cm.³/sec., as observed when measuring with ionization gauges at such low pressures⁴, are mainly due to the electron impact occurring in those gauges.

Recently I have had an opportunity of using a Knudsen gauge (for the loan of which I am indebted to Messrs. W. Edwards, Crawley, Sussex) in combination with my flow method by which gettering-rates can be measured directly⁴ instead of deriving

them from pressure-time curves. The results obtained have shown that, contrary to expectations, electron impact has little influence on the properties of barium getters.

The experimental arrangement used for these measurements was similar to that described earlier⁴, the only difference being that the ionization gauge on the far side of the capillary (right-hand side of Fig. 1, ref. 4) was replaced by the Knudsen gauge, which had a sensitivity of 3×10^{-8} mm. mercury/mm. scale. To this gauge a side tube of 30 mm. diameter was connected in which the getter and the diode used for producing the electron impact were located. The total volume on the far side of the capillary was about 1 litre.

For pumping, a single-stage and a two-stage diffusion pump in series were used. These were operated with silicone oil, omitting any liquid-air traps. After the glass equipment had been baked for between one and three hours, a pressure of about 1×10^{-7} mm. was measured in the Knudsen gauge. Immediately after the bake, gas adsorption on the glass surfaces (total area about 1,000 cm.²) was tested. Using a pressure of 5×10^{-8} mm. on the pump side of the capillary, this adsorption came to an end after 30 sec., while sorption obtained under the same conditions by a barium getter (area 8 cm.²) was detectable for about an hour.

The barium getters were deposited from KIC-getter wires at pressures between 10^{-3} and 10^{-4} mm. During measurement of gettering-rates, the pressure above the getter was between 10^{-7} and 10^{-8} mm. The electron impact was generated in a diode consisting of either a tungsten or tantalum cathode and an anode made from either nickel or tantalum sheet, located at a distance from the cathode varying between 5 and 35 mm. The anode voltage was 100 V., and the electron current about 10 mamp. The influence of the hot cathode alone on the value measured for the rate of sorption was negligible with carbon monoxide and oxygen, but of considerable magnitude with hydrogen (≈ 500 cm.³/sec.).

As shown in the accompanying table, high gettering-rates were obtained in the systems barium-oxygen and barium-carbon monoxide without any electron impact. It was carefully checked that these high rates were neither due to, nor influenced by, the electrons passing in the ionization gauge in the manifold (left-hand side of Fig. 1, ref. 4) or by the potential across the heater of the Knudsen gauge (10 V.).

During the experiments, the getters were kept at different temperatures in the range 50°–220° C. Within the accuracy of the measurements a temperature dependence of the gettering-rate could not be detected, which means that this dependence was equal to or less than 10 per cent for barium-carbon monoxide and equal to or less than 2 per cent for barium-oxygen. From the latter value it can be

INFLUENCE OF ELECTRON IMPACT ON GETTERING-RATES (in cm.³/sec.)

Getter	Gas	Getter area (cm. ²)	Number of measurements	Average value of gettering-rate without impact	Average value of gettering-rate with impact
Barium	Oxygen	6	7	1,300	1,250
"	Carbon monoxide	6	5	1,900	1,900
"	Hydrogen	6	3	50	not measured
Magnesium	Carbon monoxide	30	2	7	12

concluded that the appropriate activation energy is smaller than 0.05 k.cal./mole. These activation energies are much smaller than those measured by Arizumi and Kotani⁶ and Kobayashi and Furaya⁷ at higher pressures (5-8 k.cal./mole).

Acknowledgment is made to the Engineer-in-Chief of the General Post Office for permission to make use of this information. I also wish to thank Mr. R. E. Thorne and Mr. J. H. Phippen for their assistance in the experiments.

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Preparation of Dephosphorized Casein by an Enzymic Method

Plimmer and Bayliss¹ showed as early as in 1906 that the phosphorus of casein could be completely removed as inorganic phosphate by the action of 1 per cent sodium hydroxide at 37° C. in 24 hr. Acidification of the digest after the completion of dephosphorylation precipitated a substance resembling casein. Rimington² analysed the dephosphorized casein for its nitrogen distribution and noticed little difference in composition from that of casein except in amide and arginine nitrogen. The low values obtained in these two cases were evidently due to the hydrolytic action of alkali on these compounds with the production of ammonia. Plimmer and Lawton³ found besides that by the action of $N/4$ alkali on casein there was formed in addition to casein a substance or mixture of substances resembling a primary protease. The use of alkali as a dephosphorylating agent was considered to be undesirable for these reasons.

Enzymic methods have come into vogue recently in studies of this type. The preparation of dephosphorized phosphovitin by Mechem and Oloott⁴ and of phosphorus-free ovalbumin by Perlmann⁵ deserves special mention in this connexion. In the present investigation a purified preparation of phosphoprotein phosphatase obtained by us from ox spleen⁶ has been used for the preparation of dephosphorized casein. For the preparation of the protein the following method has been adopted.

1 litre of the digest containing 25 gm. of casein, 25 ml. of the pure enzyme preparation (283.5 phosphatase units per mgm. of protein nitrogen) and thioglycolic acid (activator) to a final concentration of 0.001 *M* was adjusted to a pH of 6.0 by veronal-acetate buffer. At the end of 24 hr. incubation at 37° C., a further quantity of enzyme preparation (10 ml.) was added to the digest. A precipitate had begun to separate by this time. When there was no more increase in the liberation of inorganic phosphorus (96 hr.) the precipitated protein was separated on the centrifuge, washed repeatedly with water and finally with acetone. The air-dry product weighed 16.5 gm.

The protein is a white amorphous powder lighter than casein. It is relatively insoluble in water. It is, however, soluble in dilute alkali and its solubility in

dilute acids is greater than that of casein. It can be precipitated from its alkali solution by acidifying to pH 6.0. There seems to be thus a shift in the isoelectric point of casein to the alkaline side during its dephosphorylation, presumably due to the removal of the phosphoric acid groups.

The protein has a nitrogen content of 15.7 per cent and contains about 0.03 per cent of phosphorus. Its content of arginine, histidine, cystine and tryptophan as determined by standard chemical methods resembles closely that of casein. No drastic changes appear to take place during enzymic dephosphorylation. The protein has also been found to be readily attacked by proteolytic enzymes. Alkali-dephosphorylated casein is attacked by these enzymes with difficulty⁷, possibly due to some racemization having taken place during alkali treatment. The lowering in nitrogen content brought about by alkali is another serious defect in the use of this reagent as a dephosphorylating agent. Since these drawbacks are eliminated by enzymic dephosphorylation, phosphoprotein phosphatase should prove to be a useful tool in studies on dephosphorylated proteins.

The complete amino-acid make-up of the protein is under investigation, and details of this work will be published elsewhere.

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"Role of Plasmagenes"

IN Prof. C. H. Waddington's review of the book by Boris Ephrussi, "Nucleo-cytoplasmic Relations in Micro-organisms"¹, the major adverse criticisms do not, in my opinion, stand up to close examination.

First is the imputation that Ephrussi does not understand, or at least recognize, that "A property of genetic continuity is attributed to both nuclear genes and plasmagenes, but the evidence for it is of quite different, in fact almost opposite, nature in the two cases. Nuclear genes are considered to exhibit genetic continuity because they continue in existence throughout lengthy series of crosses, etc., whereas the evidence for the continuity of plasmagenes is the fact that if they are got rid of they cannot be regenerated". Now the fact is that, whereas nuclear genes and plasmagenes have been detected on the basis of somewhat different criteria, their common attribute of genetic continuity is based on essentially the same properties and observations. In so far as present knowledge permits the definition of plasmagenes and nuclear genes, Waddington might have more soundly compared them along the following lines, which would have led to a quite different approach to the point at issue.

(1) Neither a nuclear gene nor a plasmagene is recognizable unless found in differential states of activity and inactivity, or presence and absence.

(2) Both are considered to exhibit genetic continuity because they continue in a lengthy series of cell generations over which some characteristic referring back to the 'gene' is faithfully recurrent.

(3) So far as one really knows, neither can be regenerated.

(4) The two types of genes are distinguishable because in sexual reproduction nuclear genes follow precise segregational patterns based on chromosomal mechanics while cytoplasmic genes do not.

(5) The criteria and the experimental means for the detection of plasmagenes require much more careful consideration than has usually been given them in the past. (This point has often been ignored by geneticists but is critically treated by Ephrussi on pp. 116-118 of his book.)

Second is Waddington's objection that bringing plasmagenes into play to explain differentiation leads to confusion. His argument is that 'Either the plasmagenes arise *de novo* during development, in which case they are doing exactly that thing the impossibility of which is used as a means of detecting them; or they are all present, possibly in an inactive form, in the unfertilized egg, in which case they are nothing but our old and discredited friends the 'organ-forming substances' appearing under a new name and with their hair curled in the latest fashion'. In all fairness, it should have been pointed out that any difficulties in the interpretation of differentiation that arise out of the second alternative apply to nuclear genes as well as plasmagenes.

Third, in the final paragraph of the review, Waddington states: "True, he [Ephrussi] starts off on the wrong foot, arguing rightly enough (on p. 4) that development involves a 'differential [which] must have its seat in the cytoplasm', but drawing the complete *non sequitur* that 'if the cytoplasm causes differentiation it must be endowed with the power of perpetuation of cell-type'". This statement of *non sequitur* is based on the quotation of two isolated fragments taken out of context, and appears to me to be a serious misrepresentation of Ephrussi's position. Actually, in the text, both before and between the two fragments quoted in the review, there is important material that establishes the general line of argument. Essentially this material is in reference to highly significant experiments in tissue culture, which show that differentiated cell types may breed true indefinitely. *Non sequitur* implies that a conclusion has been drawn fallaciously from irrelevant premises. Reference to the text clearly shows that Ephrussi has not been guilty of such an error, since his statement in question is not derived from the purported premise but is reasonable interpretation of a set of investigational observations that are under discussion.

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¹ *Nature*, 172, 784 (1953).

I WELCOME the opportunity to try to clarify a little further the difference of opinion between Prof. Srb and myself, which concerns rather the question of how the 'plasmagene' theory should be incorporated into general biological thought than the particular instance of Ephrussi's book, as to the high value of which we both agree, though it seems from different points of view.

The point I wished to make in my review was that many approaches to the 'plasmagene problem' seem

to me to take it back-to-front. Thus Srb himself suggests that we should start by defining plasmagenes; he gives four points which say in effect that they are just like nuclear genes except that they happen to lie in the cytoplasm; and it is only in his fifth and last that he raises the "criteria and the experimental means for the detection of plasmagenes", which to my mind is a demure way of hinting that quite possibly no such entities as have been defined exist at all. I believe that a more useful method of discussion would be to start from the empirical facts and proceed cautiously towards the definition.

Prof. Srb's second paragraph does not persuade me to change my opinion that it is more difficult to account for a process of change (of cell-type during differentiation) in the face of two sets of persistent entities (genes and plasmagenes) than of only one set. As to the two quotations referred to in his third paragraph, they are both taken from p. 4 of Ephrussi's book. The two sentences which separate them rather tend to reinforce than to contradict the possibility that the persistence of differentiated cell-types is due more to irreversible nuclear changes than to cytoplasmic determinants; and they certainly do not refer to the tissue culture evidence, which in any case does not prove the point one way or the other.

I am glad to reiterate the point with which I ended my review. The great merit of Ephrussi's book is that, starting by an exposition of the arguments which have led many people to suggest that the idea of plasmagenes gives us a simple explanation of development, he comes at the end to advocate the more cautious and empirical approach. His discussion, in the Addendum to the main body of the book, of the criteria for the recognition of plasmagenes (to which Srb refers) is particularly valuable; but the whole progression of his thought is, as I hope I sufficiently emphasized, of the greatest interest, and makes his book one of outstanding importance in the history of these questions, which are among the most fundamental with which biology is concerned at the present time.

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Are Inbred Strains Suitable for Bio-assay?

GRUNBERG¹ has directed attention to two properties of inbred strains which should counsel caution in their use for some experimental purposes: (1) They cannot be relied upon to remain constant in their heritable properties with the passage of time, and may diverge quite rapidly when split up into separate sub-strains and colonies. (2) They do not constitute phenotypically uniform material, but may, on the contrary, be strikingly more variable than the F_1 hybrids between strains.

This second proposition, for which Livesey² obtained experimental evidence in 1930, calls into question the established practice of using inbred material for the bio-assay of food factors, hormones, drugs, poisons, pathogens, etc. In such experiments precision in the estimates, and hence uniformity in the test organisms, is of the highest importance.

The characters measured in bio-assay are of the type usually termed 'physiological', whereas the

Exp.	Stock	Gm. 'Nembutal' per cent	Mean log response time	Antilog (min.)	Sum of squares	Degrees of freedom	Estimate of variance
I	Inbred	0.65	1.412	26	0.4896	13	0.0377
	F_1 hybrids	0.65	1.125	13	0.1827	8	0.0223
	"Mousery"	0.65	1.552	46	0.4853	13	0.0373
II	Inbred	0.65	1.593	39	0.8868	9	0.0988
	F_1 hybrids	0.85	2.110	129	0.2304	16	0.0150
	"Mousery"	0.65	2.185	153	0.5901	18	0.0453
Combined	Inbred				1.3784	23	0.0597
	F_1 hybrids				0.4231	24	0.0176
	"Mousery"				1.0744	26	0.0413

examples cited by Grüneberg all relate to morphological variation. None the less, the interpretation of the phenomenon advanced by Robertson and Reeve² and by Rasmuson⁴ would imply that we are dealing with a general biological law which must be expected to apply no less to 'physiological' than to 'morphological' characters. "The more heterozygous individuals," write Robertson and Reeve, "will carry a greater diversity of alleles, and these are likely to endow them with a greater biochemical versatility in development. This will lead to . . . a reduced sensitivity to environmental variations, since there will be more ways of overcoming the obstacles which such variations put in the way of normal development."

Two experiments on variation in a 'physiological' character have, in fact, just been published. Yoon⁵ has found in mice that F_1 hybrids are less variable in time of vaginal opening than the parental strains. Maynard Smith and Maynard Smith⁶ working with *Drosophila subobscura* have found a decreased variability in rate of development associated with heterozygosity for a marked chromosome.

We have recently conducted experiments with mice on the variation of a character chosen to be of the type measured in bio-assay, namely, the duration of narcosis following the intraperitoneal injection of 0.10 ml. per gm. body-weight of a dilution of a proprietary preparation ('Nembutal') of pentobarbital sodium.

We compared the variability in response of samples of three stocks of mice: inbreds from the *C57BL* strain, F_1 hybrids from *C57BL* ♀ × *C3H* ♂ crosses, and random-bred albinos supplied by "The Mousery", Rayleigh, Essex. Unfortunately, it was not possible to include a sample of the other parental strain (*C3H*). The duration of narcosis was expressed as the logarithm of the number of minutes elapsing from the abolition to the reappearance of the righting reflex. The logarithmic transformation was adopted in order to eliminate dependence of the variance upon the mean, and was found to be satisfactory for this purpose.

There were indications of differences in response both between the sexes and among different litters. In order to eliminate these sources of variation, the variances were estimated from the within-sexes within-litters sums of squares.

Two similar experiments were done on two separate occasions. On each occasion the three groups of mice were tested concurrently. In the second experiment, the hybrids were given a larger dose to compensate for their greater resistance to the drug. All mice were in the age-range 4-7 weeks, and those belonging to the same group in the same experiment were always born within the same eight days. The results of the two experiments were in substantial agreement, and are set out in the accompanying table.

It will be observed that the variance of the response is about three and a half times as great in the inbreds as in the hybrids. The difference is statistically highly significant, as judged by the χ -test ($P < 0.01$). In terms of a hypothetical bio-assay experiment, three and a half times as many of the inbred as of the hybrid mice would have to be used in order to obtain results of

the same accuracy.

More surprisingly, although the "Mousery" mice are as expected more variable than the hybrids, they are not more variable than the inbreds. On the contrary, the inbreds are more variable by half as much again. This difference, although not formally significant, should be regarded as suggestive, since the variability of the "Mousery" mice was almost certainly over-estimated in this experiment. It was not known which of these mice were litter mates. Hence the sum of squares used to estimate their variance includes a component which was eliminated in the analysis of the other two groups, namely, that due to differences between litters.

A more clear-cut indication that genetically heterogeneous random-bred mice may sometimes be less variable than inbred material was obtained as early as 1939 by Emmens⁷, who compared the variability of response to oestrone of a sub-strain of the *CBA* inbred strain of mice with that of a random-bred mouse colony. The variance of the inbreds, derived from the slope of the probit dosage-response curve, was about two and a half times that of the random-bred mice, and the difference was statistically highly significant.

Whether random-bred material is more or less uniform in a given case than inbred will, of course, depend upon circumstances which include the particular character which is measured and the genetical composition of the stocks which are compared. As regards the latter, the issue will be largely decided by the balance between the greater genetic variability among the random-bred organisms, making for phenotypic variability, and their greater heterozygosity, making for phenotypic uniformity.

The evidence suggests that the widely adopted policy of using inbred strains for bio-assay may be a mistaken one, and that inter-strain F_1 hybrids are to be preferred. Such material combines the genetic uniformity of inbred strains with the 'buffering' action against environmental variations which heterozygosity exerts.

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Occurrence of *Chthamalus stellatus* (Poli) in Fair Isle and Shetland

THE Mediterranean/Atlantic littoral barnacle, *Chthamalus stellatus* (Poli), is at the northern limit of its range in Britain, and is confined to the south-west, west and north coasts. In the English Channel it is not recorded east of Swanage^{1,2} and Flamanville; but there are a few old records for two places far beyond these limits—at and near Heligoland (recorded several times during the nineteenth century³, but stated to be absent by more recent authors), and in the harbour at Anholt in the Kattegat (present March 1913, but absent in 1934⁴). The most northerly records to date are those for north-east Scotland⁵ (confirmed during 1951 by Dr. J. R. Lewis and me), where the species is finally represented only by sparsely scattered, but well-developed, individuals; Stephensen's record for "Norway, S. of Lofoten"⁶ would appear to be in error.

It is therefore of interest to record the presence of *C. stellatus* on the mainland of Shetland, as well as on Fair Isle, during June 1952; in all cases *Chthamalus* occurred above a belt of *Balanus balanoides*:

1. *Shetland* (June 24): *Chthamalus* scarce on the only exposed coast examined, in the south-west of the mainland (in Muckle Sound, just north of Spiggie Voe; position 59° 56' 46" N., 1° 20' 32" W.). Eleven of the larger barnacles were collected, and measured as follows: mean rostro-carinal length 7.6 mm. (range 4.8–10.0 mm.); mean breadth 6.7 mm. (4.5–9.5 mm.). Only three of these specimens were growing sufficiently close together to have been capable of cross-fertilization, and only these contained early-stage embryos.

2. *Fair Isle*: a number of coasts were examined, but *Chthamalus* was found only at the following two exposed places: (i) east coast (June 25)—scarce, at tip of headland (Landberg) on east flank of Mavers Geo (59° 32' 7.6" N., 1° 36' 22.5" W.). (ii) South-west coast (June 30)—frequent, on very exposed reefs south-west of South Lighthouse (59° 30' 50.7" N., 1° 39' 7.4" W.); twenty-six of the larger barnacles were collected, and nineteen undamaged specimens measured, as follows: mean length 9.0 mm. (range 6.1–11.2 mm.), mean breadth 8.9 mm. (6.0–12.2 mm.). Sixteen of the twenty-six barnacles contained developing embryos; the least developed were at a very early stage, but the most advanced were quite mature, measured 0.23 × 0.13 mm. (size of egg-case; mean of twenty-five from largest barnacle), with some ready to release nauplii.

The sizes of *C. stellatus* at these new northern limits of its range are comparable with the mean and maximum sizes attained in the Firth of Clyde (personal observations), the Isle of Man⁷, and Lancashire⁸, and with the largest mean sizes recorded near Plymouth (8.0 mm. mean diameter at an estimated age of four years)¹ and near St. Malo (6.3 mm. after three years growth in an exposed situation)⁹. The sizes of the largest barnacles suggest at least three or four years growth. Thus growth is not inhibited and there was no evidence of abnormal mortality or sterility of either young or old barnacles, such as might be expected if, as has been suggested by several authors, low winter temperatures were critical for survival of the species at the northern limits of its range.

These observations lend support rather to the view that the present over-all limits of distribution of

C. stellatus on British coasts are probably determined by factors affecting survival of the planktonic larval stages rather than of the hardy adult barnacles. In this respect it is of interest that at least some larvae in Shetland waters must have survived lower summer surface seawater temperatures (maximum in August 11°–18° C.) than are normally found anywhere else around the British Isles or throughout the North Sea¹⁰. Further, seawater temperatures off south-west England are normally higher from June to November than the Shetland August maximum, suggesting that both the reported failure of the early and late broods in the south-west¹, and the absence of *C. stellatus* east of Swanage, are due to environmental factors that are unfavourable for survival of larvae in some respect other than a direct temperature effect. These unknown limiting factors could be a shortage or absence of suitable planktonic food organisms at the appropriate time of year, and/or a generally unfavourable chemical environment (cf. the observations of Wilson¹⁰ on the poor survival of larvae of certain other marine invertebrates in Channel water as compared with Atlantic water).

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Ants *Myrmica rubra* L. and *M. scabrinodis* Nylander as Intermediate Hosts of a Cestode

DURING recent ecological investigations of the ant fauna of heather moor in the west of Scotland, two of the commonest species in this region, *Myrmica rubra* L.¹ and *M. scabrinodis* Nylander, have been found to be acting as the intermediate hosts of a cestode. The cysticercoids lie freely in the body cavity and are extruded as soon as the cuticle is ruptured. They are ellipsoidal in shape (Fig. 1), measuring 530–700 μ by 340–400 μ , are very active and contain numerous calcareous granules. No suggestion of a cercarium has yet been seen. The larval scolex is often extruded very soon after the cysticercoid is removed from the ant and placed in saline. In most cases the scolex breaks away from the cyst, the rupture occurring at the base of the larval neck, and thereafter it progresses by movements of the suckers.

The dimensions of the scolex vary with the state of contraction; but in its relaxed condition it is approximately 300 μ long by 180 μ in diameter. The rostellar ring is 50–60 μ in diameter and consists

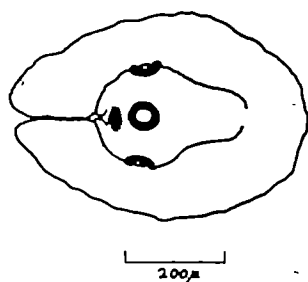


Fig. 1

of a double row of T-shaped hooks pointing outwards (Fig. 2), 13–16 μ in length and numbering about 180. The hooks of one row alternate with those of the other. The rostellum is invaginated in the scolex. The four suckers, 50–65 μ in diameter, are each armed with one compact row of hammer-shaped hooks 8–12 μ in length (Fig. 3). There are about 240 per sucker, all pointing towards the centre.



Fig. 2

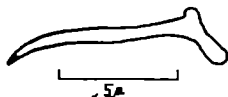


Fig. 3

The cysticercoids have been found in males, queens and workers of both species, the infected ants being detected by an unnaturally dark chocolate coloration affecting the whole cuticle, compared with the dark reddish-brown tint of non-infected individuals. This colour difference may be due to the formation of a melanoid pigment from the excretions of the parasite. Estimates based on dissection of five hundred individuals, of both species, from those regions where the infection occurs suggest that at least 8 per cent are infected. Although the majority of infections consisted of a single cysticercoid, the number may be very much greater. The maximum observed was fifty from one *M. rubra* queen.

As regards the definitive host of this worm, an investigation has shown that the red grouse, *Lagopus scoticus scoticus* (Latham), of the regions examined carry heavy infections of the widespread grouse cestode *Raillietina* (*Paroniella*) *urogalli* (Modeer, 1790), the intermediate host of which is unknown. A comparison of the scolices of these worms and those of the ant cysticercoid suggests that they are identical in all respects; further, no infections have been found in ants from regions other than grouse-moor. Experimental proof of the identity of the cysticercoid is not yet available.

This appears to be the first recorded instance of the above two species of ant acting as the intermediate hosts of a cestode. M. F. Jones and M. W. Horsfall², in the United States, have given an account of *Tetramorium caespitum* L. as an intermediate host of *R. (Raillietina) echinobothrida* (Magnin, 1881), and Ch. Joyeux and J.-G. Baer, in France, mention *Tetramorium semilaeve* André³, also *Pheidole* sp.⁴, as transmitting the same worm. The latter authors further⁴

incriminate *T. caespitum* and *Pheidole* sp. as intermediate hosts of *R. (Raillietina) tetragona* (Molin, 1858), and *Formica rufa* L. as intermediate host of *R. (Raillietina) friedbergieri* (v. Linstow, 1878).

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Diurnal Rhythms in *Periplaneta americana* L.

In the cockroach *Blatta orientalis* there appears, in both laboratory experiments¹ and in natural infestations², a rhythm of activity under normal conditions of light and darkness taking the form of a burst of activity in the early part of the night, mainly before midnight, and a quiescent period in the later part of the night and during the day. This rhythm can be eliminated by keeping the insects under constant light, when activity becomes random; normal activity is, however, continued for at least three days under the new conditions. A similar rhythm occurs in *Periplaneta americana*³.

The type of carry-over of the rhythm under new conditions suggests that a hormone may be involved in the control of activity rhythms. Experiments have been performed in which two *P. americana* cockroaches have been joined together in parabiosis. The top cockroach, which had had the legs removed and was immobile, had previously been subjected to normal conditions of light and darkness and been found to have a normal rhythm of activity; the bottom, mobile cockroach had been left in constant light for its whole life and had no rhythm of activity. The activity of this parabiotic pair was then measured under constant light and they were found to have a rhythm of activity corresponding closely to that of the 'normal' top cockroach. If left in constant light over a period of six or seven days the rhythm was gradually lost. The reverse positions were also tested, the top cockroach having before parabiosis no rhythm, and the bottom mobile one a normal rhythm. The bottom cockroach continued to show a normal rhythm of activity.

Cloudeley-Thompson⁴ has shown that the light acts through the compound eyes and ocelli; painting over both causes a loss of rhythm. He also showed that decapitation caused a loss of rhythm, a feature which is well known in other insects where decapitation causes complete cessation of activity. Roeder maintains⁵ that the head ganglia exert a general control over locomotion. If this be so, the loss of rhythm after decapitation does not so much indicate the position of the controlling centre of the rhythm, as that there has been interference with the mechanism by which it is effected.

Two cockroaches which had been kept in constant light and had no rhythm were joined together, the eyes of the bottom mobile one painted over, and the pair placed in normal light and darkness. A normal

rhythm of activity was developed. After painting over the eyes and ocelli of both cockroaches of a pair in which the top one had no rhythm and the bottom mobile one a normal rhythm, the pair still showed a normal rhythm, but lost it in two days.

It would appear from the foregoing experiments that a secretion, carried in either the blood or tissues, is involved in the production of a diurnal rhythm of activity in the cockroach.

Work is proceeding on an investigation of the region forming the secretion.

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Effect of Mineral Status on the Concentration of Rubber in *Hevea brasiliensis*

UNDER certain conditions, *Hevea brasiliensis* will respond to the application of fertilizers^{1,2}, which may give an increased yield of rubber per tree³. This increase is generally attributed to the enhanced growth and vigour of the tree, which consequently gives a greater output of latex. There is, however, no published evidence to show that the rubber concentration within the tissues can be influenced by the mineral status of the plant. The following describes briefly the main results of an experiment which bears on this point.

Seedlings of clone Tjirandji 1 were grown in sand culture under conditions of complete nutrient supply and also with a deficiency or low level of nitrogen, sulphur, phosphorus, magnesium, potassium, calcium, iron, manganese and boron. The plants were sampled four, five and seven months after sowing. The laminae were analysed for the mineral constituents while the stems and petioles were bulked together, dried, milled, extracted with warm benzene and the rubber in the extract determined after evaporation and alkaline hydrolysis⁴.

The values obtained for the total dry weight of shoot and roots per plant for the complete nutrient treatments were significantly higher than those of all other treatments with the exception of boron deficiency, which did not show a depression until the last sampling. The disparity between the complete nutrient plants and those of other treatments became more marked with time. Leaf deficiency-symptoms were observed in plants without, or with low supplies of, each of the elements except calcium and boron.

At the first sampling the 'complete nutrient' plants contained a significantly higher concentration of rubber in the stems and petioles than plants receiving other treatments. The decrease obtained in the boron-deficient plants was striking even though they did not exhibit leaf symptoms and appeared, visually, to be the most healthy and vigorous plants in the experiment.

At the second sampling, when the plants were five months old, the rubber concentration in the stems and petioles of the complete nutrient plants was still significantly higher than for the plants deficient in iron or boron. The rubber concentration was par-

ticularly low in the boron-deficient plants, which did not differ significantly from the complete nutrient plants in respect of dry weight per plant.

At the seven-month stage the dry weight yield per plant for each deficiency was significantly lower than for the complete nutrient plants. The concentration of rubber in the stems and petioles, however, generally exceeded that of the complete nutrient plants except for boron deficiency. It was apparent that whenever the dry weight yield per plant was low, the rubber concentration tended to be high.

Thus it was inferred that mineral status will only have a direct effect on rubber concentration in the earlier stages of growth when the yield differences between complete nutrient and deficiency treatments are relatively small. The gradual decrease in the rubber concentration observed with each successive sampling was probably due to the increasing proportion of non-latex producing tissue and the mode of expression of the results as a proportion of the total stems and petioles per plant. If it proves possible in future work to estimate the rubber in newly produced leaves or young tissues, a direct effect of mineral status on rubber concentration may even be obvious in old plants.

The concentration of the withheld nutrient in the laminae of the deficient plant was usually lower than that in the complete nutrient, although this was not always so for the sulphur- and iron-deficiency treatments.

The results demonstrated that nutrient deficiencies caused a reduction in the rubber concentration of the bulked stems and petioles in the earlier stages of growth only, before the differential effect of mineral treatment on yield response had become acute. The total rubber content of the plant was, however, governed by the dry weight production, which in turn was dependent on mineral status. Accordingly it must be expected, under field conditions, that where nutrient deficiencies are sufficiently severe to cause an appreciable decrease in the vigour and dry-weight production of the plant, a smaller yield of rubber per tree will result.

A fuller account of the experimental results will appear in the *Journal of the Rubber Research Institute of Malaya*.

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Significance of the Ratio between the Water-soluble Aromatic and Nitrogen Constituents of Apple and Pear in the Host-Parasite Relationships of *Venturia* Species

VARIOUS workers have directed attention to the possible importance of aromatic host constituents in associations between plants and pathogens¹⁻³. Recent work at East Malling^{4,5} on the water-soluble constituents of apple and pear leaves and stems has made possible a detailed investigation of the biochemical aspects of host-parasite relations in *Venturia*

inacqualis and *V. pirina*, the causal fungi of apple scab and pear scab respectively.

Cultural studies have shown that the aromatic fraction of the water-soluble constituents (that is, the complex mixture of plant phenols extracted by ethyl acetate) and its separate main components may be strongly inhibitory to the growth and sporulation of the pathogen, depending on the complexity and amount of the nitrogen source. A high level of amino-nitrogen in the culture medium, for example, may result in complete degradation of the aromatic compounds by exogenous activity of a polyphenol-oxidase system secreted by the fungus. Conversely, an inorganic, or low-level amino-nitrogen, supply favours the inhibitory activity of aromatic compounds, resulting in all stages between reduction in sporulation and complete inhibition of growth. Marked differences in reaction to a given aromatic/nitrogen ratio have been observed between different clones of each pathogen.

By injection of inoculated apple and pear shoots with the aromatic fraction of leaf extracts, and urea, separately and in combination, evidence has been obtained of a similar mechanism operating *in vivo*. Using potted apple and pear trees under glass, shoots were enclosed in polythene-sleeve moist chambers as described by Stanton⁶ and inoculated by spray application of conidial suspensions. Injections were carried out during the incubation period of infection using a modification of the Roach method^{1,2} of petiole injection to ensure even permeation of the leaves on the shoot thus injected. Nine replicate leaves of similar age on nine shoots were used in each treatment, and disease expression was recorded by estimation of percentage cover by scab lesions on both leaf surfaces. The accompanying table is an example of the results obtained in a series of inoculation and injection experiments. Water injection had no effect on scab incidence as compared with uninjected shoots.

TOTAL SCAB (*V. inaequalis*, CLONE N.) IN EACH INJECTION TREATMENT ON COX'S ORANGE PIPPIN

Shoots injected with	Days after inoculation			
	14	18	21	28
Water	5.3	10.3	15.6	50.3
Cox aromatic fraction 1 per cent	0.0	0.1	0.1	3.3
Urea 0.5 per cent	17.0	47.2	61.2	102.1
Cox aromatic fraction 1 per cent and urea 0.5 per cent	23.1	24.3	31.6	54.3

Injection of the aromatic fraction of the constituents of Cox's orange pippin reduced infection markedly, while urea had the opposite effect. A mixture of this fraction and urea had no effect on the final level of infection as compared with water injection.

Mature leaves of all varieties are immune to infection. It was observed that injections produced their maximum effect on leaves approaching the mature resistant stage. It is thought that the aromatic/nitrogen ratio, at this stage of leaf development, can be most effectively altered by injection, as relatively small changes may inhibit or stimulate the pathogen. Work on the quantitative differences between young leaves of varieties characterized by varying degrees of resistance and between susceptible young leaves and immune mature leaves of the less resistant varieties is in progress.

It is suggested that the reaction of a clone of the pathogen to the aromatic/nitrogen ratio of the host

may be a critical factor controlling the level of pathogenicity observed.

A full description of these results will be given elsewhere.

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Affinity of Sambucyanin for Nucleic Acids

I RECENTLY pointed out¹ the existence in *Sambucus nigra* berries of a dyestuff (sambucyanin) which can be used as a nuclear stain. Further investigations enabled me to ascertain that such a dye has a selective affinity for nucleic acids: actually, both deoxyribonucleic acid and ribonucleic acid are markedly coloured red *in vitro* by sambucyanin, the affinity for this dye not being shown by chemical and enzymatic hydrolysis soluble products of acids. Likewise, the stainability of cellular elements in tissues disappears after using specific nucleases.

Cytochemical demonstration of nucleic acids by means of sambucyanin is carried out, as a rule, on fixed material; however, it is possible to effect cellular element staining even supravitaly, using concentrated solutions. The best results are attained by using the dyestuff in the fresh state and avoiding fermentation. Purified pigment can be obtained from raw sambucyanin by means of salification with hydrochloric acid in methanol and precipitation of hydrochloride with sulphuric ether.

Staining method. (1) Dip sections of tissues (fixed in alcohol or formalin) in a 10 per cent aqueous solution of sambucyanin for ten minutes. (2) Wash in distilled water. (3) Operate a careful differentiation in 80 per cent alcohol in order to remove any aspecific dye adsorption on the part of other tissue elements (calcareous concretions, etc.). For a quick differentiation alcohol lightly acidified with acetic acid can be used. (4) Handle eventual contrast staining with a 1:1,000 aqueous solution of light green for about one minute. (5) Again rinse in distilled water. (6) Dehydrate in absolute alcohol, clear in xylol and mount in neutral balsam.

To carry out supravital staining, mix a 25 or 50 per cent sambucyanin solution with the specimen material suspended in neutral liquid in equal parts, and allow it to remain for some minutes before checking: nucleic acids become red.

Nucleic acid staining with sambucyanin affords, in comparison with other methods, higher sensitiveness and specificity; it gives a more constant effect and is easier to use, as well as offering the possibility of supravital use.

A. NOVELLI

Department of General Pathology,

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Dec. 18.

¹ *Experientia*, 9, 152 (1953).

Alkaloids in Germinating Seeds of *Atropa belladonna*

DURING recent work on alkaloid biogenesis in *Atropa belladonna*, the results of which will be published elsewhere, we used James's method for demonstrating alkaloids in solanaceous meristems¹. This method is based on the formation of a red precipitate around a piece of plant tissue as a result of the diffusion of alkaloid in a potassium iodide-iodine solution (Bouchardat's reagent).

James tacitly assumes that the alkaloids demonstrated in germinating seeds are tropane alkaloids; but as Bouchardat's reagent is non-specific, there is insufficient proof for this.

Paper chromatography² of extracts of germinating seeds and seedlings of *A. belladonna* showed that the alkaloid which appears first is not hyoscyamine, or scopolamine, apotropine, belladonnine or tropine; but an unidentified, strongly basic alkaloid, which probably is belladadine, first isolated by King and Ware from Bulgarian *A. belladonna* root³.

Afterwards, scopolamine and then hyoscyamine appear.

P. REINOUTS VAN HAGA

Laboratory for Technical Botany,
Technical University,
Delft. Dec. 17.

¹ James, W. O., *Nature*, **180**, 377 (1945).

² Munier, R., and Macheboeuf, M., *Bull. Soc. Chim. Biol.*, **82**, 102 (1960).

³ King, H., and Ware, L. L., *J. Chem. Soc.*, 331 (1941).

Reversible Photo-oxidation of a Cytochrome Pigment in Photosynthesizing *Rhodospirillum rubrum*

THE investigation reported here is a continuation of experiments¹ on reversible changes in light absorption in purple bacteria induced by irradiation. It presents evidence which indicates that, in living bacteria in the absence of oxygen and in the presence of substrate, a cytochrome pigment is oxidized by illumination and is reduced in the dark. The bacteria used were vigorously growing, one or two days old, *Rhodospirillum rubrum*, strains 1 and 4. The growth medium for strain 1 was tap-water containing 1 per cent peptone, and for strain 4 tap-water with 1 per cent peptone and 0.5 per cent sodium chloride.

The apparatus for measuring the changes in absorption was a modification of the sensitive differential spectrophotometer described earlier¹. The change in absorption was brought about by illuminating a bacterial suspension with a beam of variable intensity, and the change was measured by means of a monochromatic scanning beam the wave-length of which could be varied. This scanning beam was at right angles to the actinic beam. It was too weak to cause a change in absorption. The source of actinic radiation was a tungsten lamp with a filter transmitting beyond 670 m μ .

Irradiation of a suspension of *Rhodospirillum rubrum* strain 1 in its growth medium under anaerobic conditions produced marked changes in absorption at about 430 m μ at

rather low actinic intensities. The original absorption was restored in the dark. These changes were complete in the time of the order of a second. The changes in absorption coefficients at different wave-lengths of a bacterial suspension produced by a constant actinic beam are plotted in Fig. 1. This curve we call the spectrum of the change in absorption. If the bacteria were suspended in 0.03 M sodium acetate plus 0.05 M phosphate buffer pH 6.8, under anaerobic conditions, instead of in peptone, a similar spectrum was produced by illumination, as measurements at a few wave-lengths indicated. A similar spectrum of the change in absorption was found for the more anaerobic strain 4 of *Rhodospirillum rubrum*, when measured in its growth medium.

At high actinic intensities a different spectrum of the change in absorption is found, the shape of which depends upon the intensity. This spectrum probably is a combination of the spectrum of Fig. 1 with another spectrum. The infra-red part of this other spectrum has been published earlier¹. The changes in absorption in the infra-red are probably due to changes in bacteriochlorophyll absorption.

The spectrum of the change in absorption of the *Rhodospirillum* suspension (Fig. 1) has a positive maximum at about 427 m μ and a negative one at about 409 m μ . Except for a shift of the maxima of about 7 m μ to longer wave-lengths, the spectrum of the change in absorption of the bacteria is similar to the spectrum obtained² by subtracting the spectrum of reduced cytochrome c from that of oxidized cytochrome c (Fig. 1, dotted line). This indicates that a cytochrome pigment is oxidized by a light reaction and is reduced by a dark reaction, as indicated by the restoration of the original absorption in the dark.

Van Niel³ provided evidence that the last step or steps of the photosynthetic dehydrogenation of the substrate in *Rhodospirillum rubrum* are the same as the last steps in the dehydrogenation of the substrate in the dark by respiration. The respiratory dehydrogenation presumably proceeds by way of a cytochrome system⁴. A cytochrome has been extracted^{5,6} from *Rhodospirillum rubrum* strain 1 similar in reducing properties to cytochromes c, but, unlike c, not oxidizable by cytochrome oxidase from pig heart⁵.

Although it is not yet possible to tell whether this cytochrome is identical with the cytochrome (Fig. 1) that is oxidized by irradiation, we may say that our experiments indicate that the photosynthetic oxidation of the substrate in *Rhodospirillum rubrum* is mediated by a cytochrome pigment.

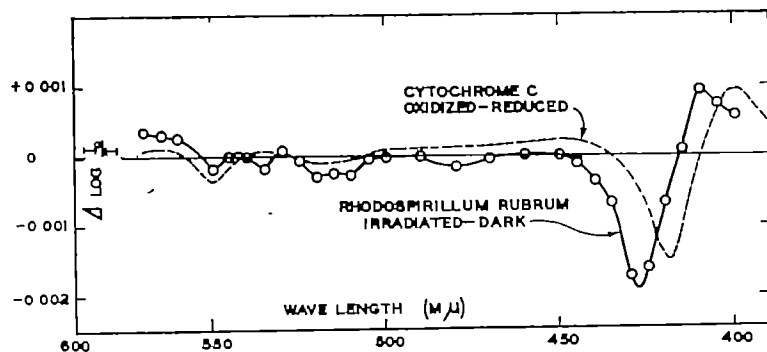


Fig. 1. Spectrum of the change in absorption of a suspension of the non-sulphur purple bacterium *Rhodospirillum rubrum* strain 1 produced by a low actinic light intensity. Difference of absorption coefficient in the light and in the dark is plotted as a function of the wave-length of the scanning beam. The absorption coefficient of the suspension at 890 m μ , corrected for scattering, was 0.9. The figure shows also the difference of absorption spectra of pure oxidized and reduced cytochrome c according to Lundegårdh (ref. 2)

A detailed account of these and related experiments will be published elsewhere.

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Dec. 22.

* Present address: Photosynthesis Research Project, University of Illinois, Urbana, Ill.

¹ Duyens, L. N. M., "Transfer of Excitation Energy in Photosynthesis", thesis, Utrecht (1953).

² Lundegårdh, H., *Arkiv för Kemi*, **5**, 97 (1952).

³ van Nieu, C. B., "Advances in Enzymology", **1**, 263 (1941).

⁴ Vernon, L. B., and Kamen, M. D., *Arch. Biochem. and Biophys.*, **44**, 208 (1953).

⁵ Vernon, L. B., *Arch. Biochem. and Biophys.*, **43**, 432 (1953).

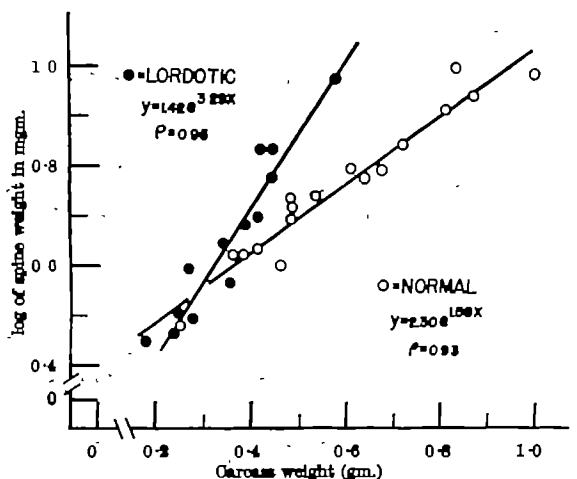
⁶ Haden, S. R., Kamen, M. D., and Vernon, L. P., *J. Amer. Chem. Soc.*, **78**, 6347 (1956).

Composition of Bone and Muscle from the Lordotic and Normal Guppy, *Lebistes reticulatus*

The hereditary nature of an abnormality of the vertebral column has been established for at least two species of fishes: *Oryzias latipes*¹ and *Lebistes reticulatus*²⁻⁴. The biological nature of the mutation is fairly well understood; but there is a paucity of information concerning the chemistry of the bone and tissues from these mutant fishes, although Harrison⁵ found the total body calcium of lordotic *Lebistes* to be high. Further studies on the distribution of bone and muscle constituents from these fishes is the basis for this communication.

Mutant *Lebistes* were reared and maintained in the laboratory⁶ while normal fishes were obtained commercially. For study, the fish were killed in boiling water. After evisceration, the carcass was weighed, the spinal column was removed and cleaned of adhering tissue, and thoracic and lumbar muscle was obtained free of skin and scales. Analytical procedures were performed by methods previously described in detail⁷.

As shown in the accompanying figure, the log-weight of the vertebral column versus carcass weight is adequately described by an exponential equation for both the mutant and normal strains. However,



Weight of the spinal column versus carcass weight for lordotic and normal female *Lebistes*

Table 1. COMPOSITION OF THE VERTEBRAL COLUMN FROM MALE AND FEMALE LORDOTIC AND NORMAL *Lebistes**

	Lordotic	Normal	"t"†	P
Calcium	14.6 ± 0.30†	12.2 ± 0.43†	4.73	<0.01
Phosphorus	7.6 ± 0.18	7.2 ± 0.13	1.74	>0.10
Ca/P	1.93 ± 0.05	1.71 ± 0.05	2.09	<0.01
No. of determinations	23	22	—	—

* All values are expressed as the percentage of dry fat-free bone.

† Student's "t" value. From Snedecor, G. W., "Statistical Methods for Research Workers".

$$t = \frac{\bar{M}_1 - \bar{M}_2}{\sqrt{\frac{\sum x_1^2 + \sum x_2^2}{N_1 + N_2 - 2} \left(\frac{1}{N_1} + \frac{1}{N_2} \right)}}$$

$$\pm \text{Standard error} = \frac{\sqrt{\sum x^2}}{n(n-1)}$$

the slope of the line of regression calculated by the method of least squares is greater for the lordotic (3.25) than for the normal (1.58), and the correlation coefficient (P) is high.

The difference in bone weight is associated with a significantly greater concentration of calcium in the vertebral bone of the mutant fish (see Table 1); but the phosphorus concentration remains the same. These data are average values of bone obtained from both sexes since no significant differences between the sexes was apparent.

The lordotic mutation not only affects the anatomy of the vertebral column but also disturbs the anatomical arrangement of the thoracic and lumbar musculature⁴. However, various analyses of muscle tissue indicate no differences in chemical constituents between the two strains (see Table 2).

Table 2. COMPOSITION OF MUSCLE FROM LORDOTIC AND NORMAL FEMALE *Lebistes*

	Lordotic	Normal
Water (% wet weight)	77.7 ± 0.3* (14)	77.1 ± 0.4* (13)
Fat (% dry weight)	6.6 ± 0.7 (14)	4.0 ± 0.6 (13)
Protein† (% fat-free dry weight)	85.2 ± 0.9 (13)	85.0 ± 0.7 (12)
Calcium " " "	0.97 ± 0.06 (10)	1.03 ± 0.11 (13)
Phosphorus " " "	1.19 ± 0.05 (10)	1.29 ± 0.08 (13)
Ca/P	0.77 ± 0.03 (10)	0.80 ± 0.03 (13)

* Standard error.

† Protein was determined from nitrogen values × 6.25.

Numbers in parenthesis indicate number of analyses performed.

It is apparent from these studies that the lordotic mutation is associated with changes in the mechanism of calcification and formation of vertebral bone.

This investigation was supported in part by a grant in aid from the Society of Sigma Xi—Research Fund. I am indebted to Messrs. W. Schaumburg and J. Detrich, of Crescent Fish Farms, New Orleans, La., for normal fish and generous supplies of live fish food.

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¹ Aida, T., *Genetics*, **15**, 1 (1930).

² Goodrich, H. B., et al. (Abstract), *Genetics*, **28**, 75 (1943).

³ Rosenthal, H. L., and Rosenthal, R. S., *J. Hered.*, **41**, 217 (1950).

⁴ Harrison, B. W., thesis, Wesleyan University, Conn. (1941).

⁵ Kirpichnikoff, V., *J. Biol. Moscow*, **4**, 343 (1935).

⁶ Rosenthal, H. L., *Biol. Bull.*, **108**, 80 (1952).

⁷ Rosenthal, H. L., *Biol. Bull.*, **105**, 100 (1953).

FORTHCOMING EVENTS

Monday, April 12

SOCIETY OF CHEMICAL INDUSTRY, CROP PROTECTION PANEL of the **AGRICULTURE GROUP** (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Fourth Annual General Meeting. Dr. R. A. R. Galley: "Some Pest Control Problems in the Colonies".

Tuesday, April 13

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.1), at 5 p.m.—Scientific Papers.

ILLUMINATING ENGINEERING SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6 p.m.—Mr. H. M. Cartwright: "Illuminants for Colour Reproduction and Printing".

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS AND POLYMER GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. R. J. W. Reynolds: "Relation Between Chemical Constitution and Properties of Polymers".

ROYAL AERONAUTICAL SOCIETY (in the Library, 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. H. Sutton: "Some Aspects of Modern Aircraft Materials".

Wednesday, April 14

ZOOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. R. W. D. Elwell: "The Lithology and Structure of a Boulder Bed in the Dalradian of Mayo, Ireland"; Dr. F. H. T. Rhodes: "The Conodont Fauna of the Keshy Limestone".

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting. Mr. G. S. Bishop: "The Storage and Distribution of the Nation's Food".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (Grade III or II) in **PHILOSOPHY**—The Registrar, The University, Bristol 8 (April 15).

LECTURER (with good honours degree and teaching experience, and preferably other postgraduate industrial or research experience) in **PHYSICAL CHEMISTRY**, and an **ASSISTANT LECTURER** (with a good honours degree, and teaching experience) in **ORGANIC CHEMISTRY**, at Leeds College of Technology—Chief Education Officer, Education Department, Leeds 1 (April 17).

SENIOR ASSISTANT CHEMIST (preferably with waterworks experience, and a member of the Royal Institute of Chemistry, or with an honours degree in chemistry)—The General Manager, Bristol Waterworks Company, Telephone Avenue, Bristol 1 (April 20).

UNIVERSITY DEMONSTRATOR (with an honours degree in engineering, preferably combined with some agricultural experience) in **AGRICULTURE**—The Secretary, School of Agriculture, Downing Street, Cambridge (April 23).

WHEELER PROFESSOR OF BIOCHEMISTRY—The Registrar, University Registry, Oxford (April 29).

ADVISER OF STUDIES IN SCIENCE—The Secretary of University Court, The University, Glasgow (April 30).

ASSISTANT LECTURER, and a **TUTOR** in the **DEPARTMENT OF GEOGRAPHY**—The Registrar, The University, Liverpool (April 30).

MYCOLOGIST in the **PLANT PATHOLOGY DEPARTMENT**—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (April 30).

RESEARCH OFFICER (Physicist) (with an honours degree in science, or equivalent qualifications, and with research experience in the use of X-ray diffraction, preferably as applied to studies of the structure of proteins or high polymers) in the **BIOCHEMISTRY UNIT**, Wool Textile Research Laboratories, Commonwealth Scientific and Industrial Research Organization, Parkville, Melbourne, to participate in an intensive programme of research on the structure of wool and other fibrous proteins by chemical and physical methods—The Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 452/81 (April 30).

ENTOMOLOGIST (with at least a specialized degree normally involving a four-year university course, and preferably with a knowledge of botany and field ecology) in the **DEPARTMENT OF AGRICULTURE** (Tsetse Fly Operations Branch), Southern Rhodesia Government, for work which may embrace laboratory and field research or investigation on tsetse fly, field reclamation and survey work—The Secretary, Southern Rhodesia Government, Rhodesia House, 429 Strand, London, W.C.2 (May 1).

PHYSICIST or **METALLURGIST**, Research Officer or Senior Research Officer grade (Ph.D.), with additional research experience, or equivalent qualifications (essential), in the **DIVISION OF TRIBOLOGY** of the Commonwealth Scientific and Industrial Research Organization, at the University of Melbourne, for work concerned with problems of plastic deformation and phase transformation—The Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 370/81 (May 1).

PROFESSOR OF PHYSICS at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, May 1).

CHAIR OF PHYSICAL CHEMISTRY tenable at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 5).

RESEARCH OFFICER (with an honours degree in science, with biochemistry or chemistry as major subjects, and research experience,

preferably in some biological field) in the **PHYSICAL CHEMISTRY**, **STATION**, Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organization, Fishermen's Bend, Victoria, Australia, to participate in a programme of research on the fixation of nitrogen by biological systems—Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting 590/447 (May 6).

SENIOR RESEARCH OFFICERS (3) (preferably with specialized post graduate training in a branch of science applied to agriculture, for example, plant physiology, soils, crop husbandry or agricultural engineering) to take charge of sugar cane research in the main ecological divisions of the sugar area—The Director of Research, Sugar Manufacturers' Association of Jamaica, Ltd., Sugar Research Department, Mandeville, Jamaica, British West Indies (May 7).

LECTURER IN GEOGRAPHY at the University of New England, Armidale, New South Wales, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 10).

DEMO STUDENT (with an honours degree in chemistry or engineering) in **CHEMICAL ENGINEERING**—The Registrar, Imperial College of Science and Technology, London, S.W.7 (May 14).

PROFESSOR OF MECHANICAL ENGINEERING, and a **PROFESSOR OF CIVIL ENGINEERING**, at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, May 15).

ASSISTANT LECTURER (preferably with special qualifications in stratigraphy and paleontology) in **GEOLOGY**—The Registrar, University College of South Wales and Monmouthshire, Cathays Park Cardiff (May 20).

LECTURER (with a good honours degree in botany, and research experience, preferably in genetics) in **BOTANY**, at the Imperial College of Tropical Agriculture, Trinidad, British West Indies—The Secretary, The Imperial College of Tropical Agriculture, 40 Norfolk Street, Strand, London, W.C.2 (June 30).

LECTURER (with knowledge of industry, and preferably with a knowledge of latex) in **RUBBER TECHNOLOGY**, a **LECTURER** (chemist or physicist, preferably with some practical experience) in **PLASTICS TECHNOLOGY**, and a **LECTURER IN PHYSICS**—The National College of Rubber Technology, Northern Polytechnic, Holloway, London, N.7.

MASTER TO TEACH BIOLOGY to University Scholarship standard—The Headmaster, Haberdashers' Aske's Hampstead School, Westbere Road, London, N.W.3.

SCIENTIFIC OFFICER (Physicist) (with first- or second-class honours degree in physics, with mathematics as subsidiary subject, or equivalent qualifications) in the Department of Scientific and Industrial Research, Water Pollution Research Laboratory, Stevenage, for research on physical problems arising in the study of polluted rivers—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A86/54A.

SCIENTIFIC OFFICERS (with first- or second-class honours degree, or equivalent, in physics or mathematics) with the Air Ministry, for operational research on a wide variety of problems, in London and the provinces, under the direction of the Scientific Adviser to the Air Ministry—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.86/54A.

SENIOR EXPERIMENTAL OFFICERS (Ref. 566), **EXPERIMENTAL OFFICERS** (Ref. 567), and **ASSISTANT EXPERIMENTAL OFFICERS** (Ref. 568) (with at least H. S. C. in science subjects) in the **DEPARTMENT OF ATOMIC ENERGY**, Culworth, near Warrington, for duties connected with analysis of materials arising in research on metallurgical and chemical processes involving rare metals—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting appropriate Ref. No.

REPORTS and other PUBLICATIONS

(not included in the monthly Book Supplement)

Great Britain and Ireland

Toxic Chemicals in Agriculture and Fisheries. Health, and Food, and to the Ministry of State for Scotland of the Working Party on Precautionary Measures against Toxic Chemicals used in Agriculture. Pp. iii+32. (London: H.M. Stationery Office, 1953.) 1s. 6d. net. [102]

Air Ministry: Meteorological Office. Professional Notes No. 108: Comparison of the Wind Recorded by Anemograph with the Geostrophic Wind. By W. A. L. Marshall. Pp. 26. (M.O. 524h.) (London: H.M. Stationery Office, 1954.) 1s. net. [123]

Other Countries

Companhia de Diamantes de Angola. (Diamang.) Serviços Culturais. Dundo—Lunda—Angola. Museu do Dundo. Publicações Culturais No. 21: Grasshoppers (Orthoptera, Acrididae) of Angola and Northern Rhodesia, collected by Dr. Malcolm Butt in 1927-1928. By Dr. B. P. Uvarov. Pp. 217. (Lisboa: Companhia de Diamantes de Angola, 1953.) [22]

Department of the Army-Corps of Engineers. Beach Erosion Board: Office of the Chief of Engineers. Technical Memorandum No. 35: Analysis of Moving Fetches for Wave Forecasting. By Kenneth Kaplan. Pp. iv+39. Technical Memorandum No. 42: A Study of Sand Movement at South Lake Worth Inlet, Florida. By George M. Watz. Pp. iv+24. (Washington, D.C.: Beach Erosion Board, Office of Chief of Engineers, 1953.) [21]

Proceedings of the California Academy of Sciences. Fourth Series. Vol. 28, No. 5: The Trombschild Mites of Japan. By Mamoru Sasa and H. W. Jameson, Jr. Pp. 247-251. (San Francisco: California Academy of Sciences, 1954.) [22]

Commodity Trade and Economic Development. (Report of the Committee of Experts on International Price Relations.) Pp. vii+102. (New York: United Nations; London: H.M. Stationery Office, 1953.) 75 cents; 5s.; 3 Swiss francs. [23]

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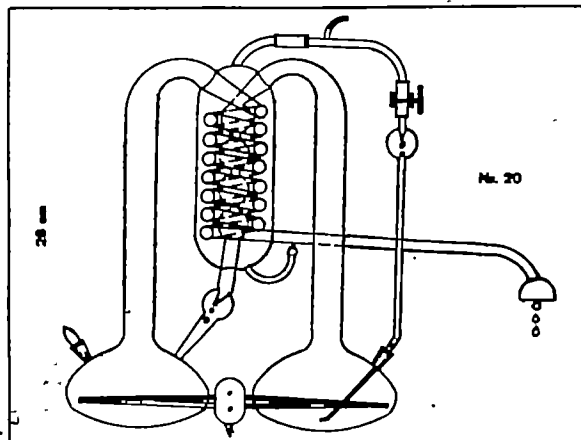
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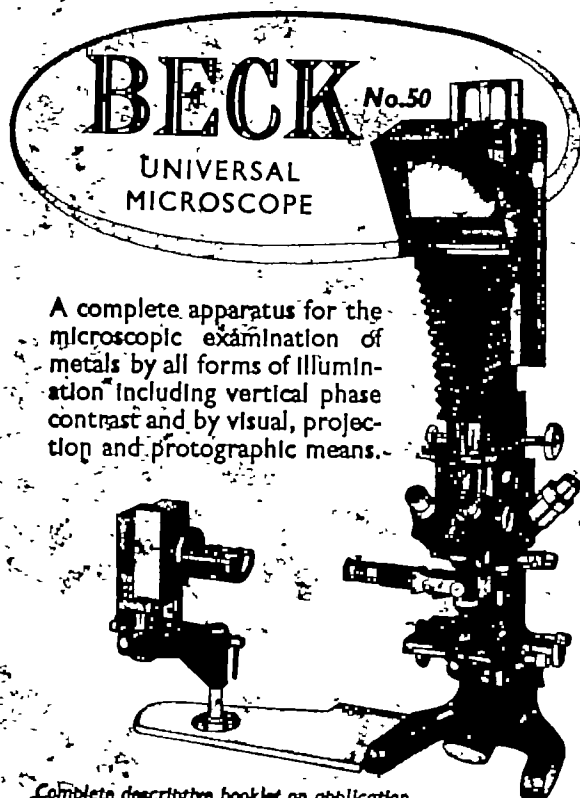
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Kings of diamonds

In his book *Oculus artificialis teleiopltricus*, the optician Zahn writing in 1685 suggested the marking of glass discs with a diamond to replace micrometers of silver wire, hairs, or silk used hitherto. There is, however, some doubt as to the date of this work, which may have been 1702.

In 1700 La Hire also suggested that a greatly improved cross-wire could be obtained by ruling with a diamond on a glass disc. Whether Zahn's or La Hire's suggestion came first is doubtful, but it can be said that the resultant diamond-ruled glass disc was the first successful graticule as known to-day. La Hire described graticules ruled on glass with 13 horizontal and vertical lines, and with 6 concentric circles both of which would make patterns in current use in microscopy to-day.

(To be continued)

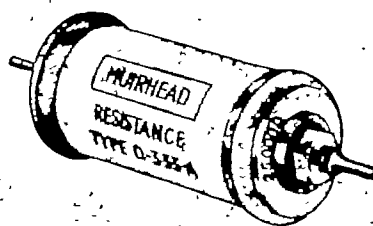
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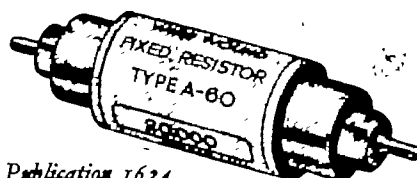
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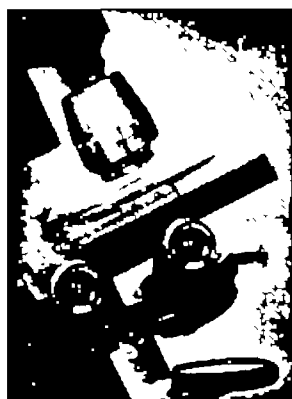


VOL. 173, No. 4408

SATURDAY, APRIL 24, 1954

TWO SHILLINGS

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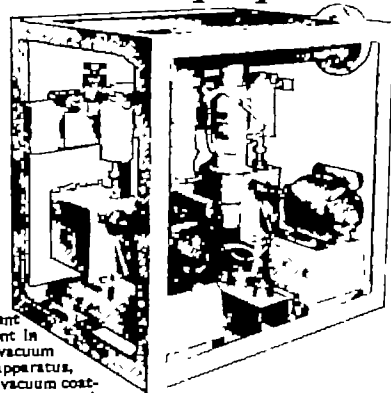
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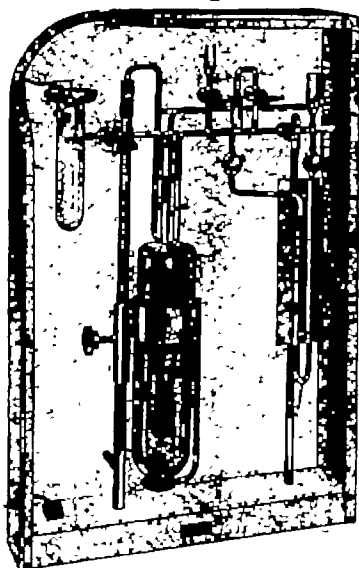
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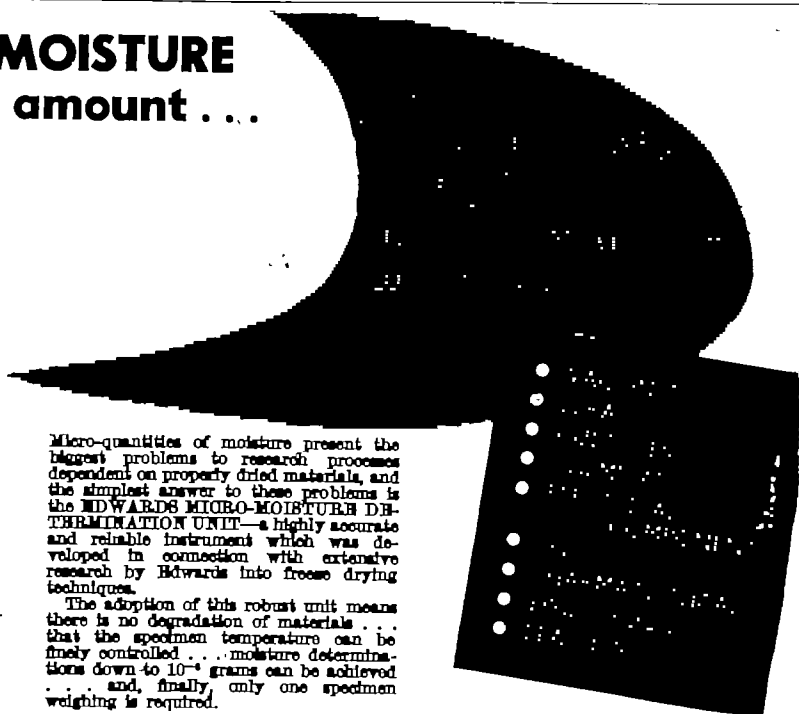
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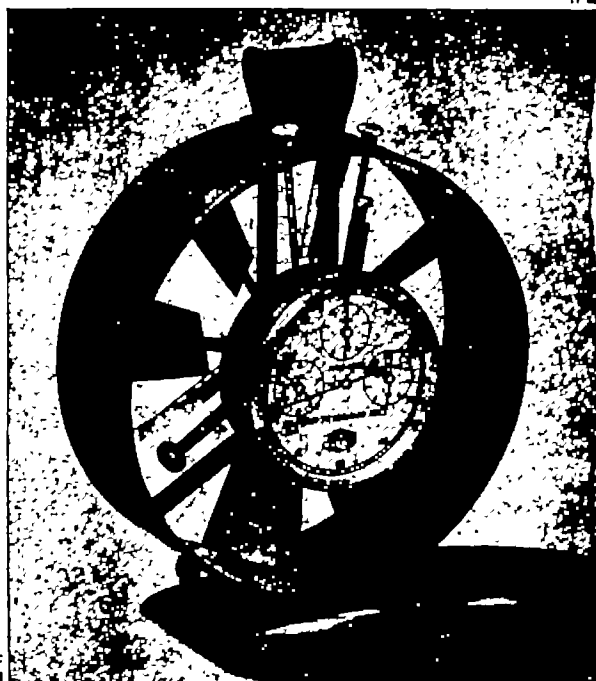
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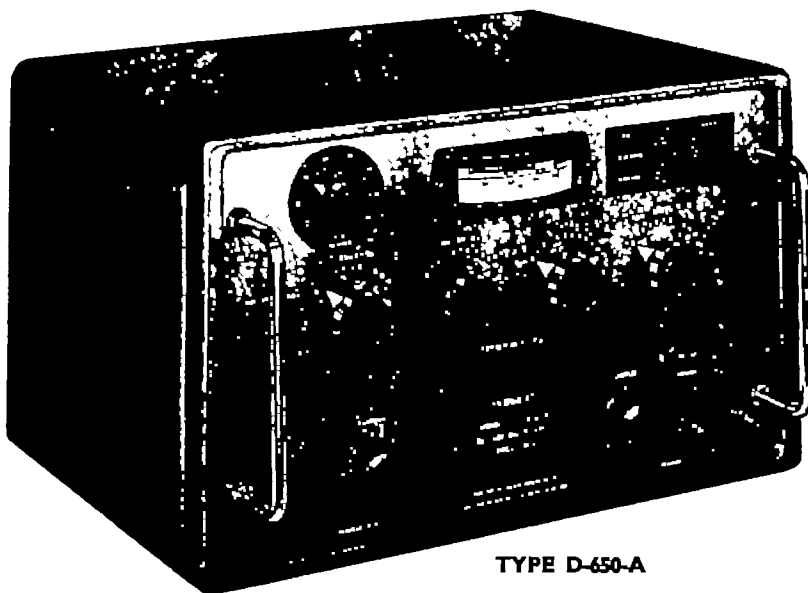
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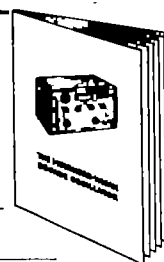
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UTILIZATION OF SCIENCE BY INDUSTRY

THE view that new scientific and technical knowledge is absorbed into certain sections of British industry too slowly, and that a scientific approach to the day-to-day problems of production and organization is less common than it should be, is widely held. It was emphasized by Sir Henry Tizard in his presidential address to the British Association more than five years ago, and it has since been accepted by the Advisory Council on Scientific Policy and found some support in the reports coming from the productivity teams of the Anglo-American Productivity Council. It was subjected to detailed analysis by Dr. R. L. Meier in his paper "The Role of Science in the British Economy" and, although in some quarters this view is regarded as mistaken, the Manchester Joint Research Council was fully justified in accepting it for the purpose of its inquiry into the relations between science and industry in the Greater Manchester area*.

This inquiry, carried out in the main by a team of three investigators, guided by a Steering Committee, during 1950-53, was not primarily concerned to discover whether this opinion is right or wrong. The investigators were interested rather in examining the reasons usually given for the alleged backwardness of British industry in this respect. The inquiry was limited to some 225 firms each employing more than fifty persons in an area of south-east Lancashire from Blackburn and Burnley to Stalybridge, Stockport and Altrincham. Some 76 per cent of the firms approached responded, and in the textile industries 20 per cent of the establishments in the area were eventually visited; in the engineering industries 17 per cent of the firms were visited; in the modern industries group, concerned with the manufacture of materials or articles unknown to society or industry a century or even fifty years ago, 22 per cent were visited; and of those in miscellaneous industries, 23 per cent.

In presenting this report, therefore, the Manchester Joint Research Council believes that the facts recorded are sufficiently representative to give a reliable basis for tentative conclusions as to the answers to some of the leading questions which at once arise out of any assumption as to the backwardness of British industry. Sometimes, for example, this is attributed to the relatively small number of scientists employed in industry, or to the absence of men of the right type or appropriate training. Alternatively, it is argued that industry does not make the best use of the scientists it does employ, or that the alleged backwardness is due to weaknesses in the organization of research and development and in their relation to production; or again, that the lack of scientific enterprise in industry is due to government control, to restrictive practices by management or labour, or to the general level of taxation.

* Industry and Science: a Study of their relationship based on a survey of firms in the Greater Manchester Area carried out by the Manchester Joint Research Council, 1950-1953. Pp. viii+188. (Manchester: At the University Press, 1954.) 12s. 6d. net.

On the validity of these last arguments, the report expresses no opinion; but, with this exception, the Steering Committee organized its inquiry so as to throw as much light on the questions that immediately arise out of the foregoing criticisms. Without expecting that the inquiry could by itself provide a conclusive answer to the arguments, it sought, for example, to accumulate facts which would, at any rate indirectly, indicate whether employment of scientists led to a progressive atmosphere and whether the presence of scientists at the higher levels of management or on the directorate made any crucial difference in the attitude or practice of the firm. In the same way, the relations between the universities and the research associations were examined so as to throw light on the question whether directly or indirectly they provided sufficient basis for all requirements, or whether there was a need and demand for new institutions. Next, light was sought on the respective roles in industry of the universities, the research associations and the research departments, their interrelationships, and the role of research and development departments in the firms themselves and the relation of these departments to other branches of the firm. These questions, moreover, are related to the earlier questions about the employment of scientists in industry, and the investigators sought specifically to throw some light on these relations between the use of scientists in industry and problems of organization and institutions.

Although the inquiry covers but a small sample of industry in Britain, it touches a wide range of problems, and the facts recorded are a useful contribution to the current discussion of such varied topics as scientific man-power and higher technological education, education for management, the functions of the research associations, the relations between universities and industry, the work of the National Research Development Corporation, information services and the like. It is less searching and exhaustive in its treatment of the research associations than either Prof. R. S. Edwards's study, or the particular analysis of the work of the British Leather Manufacturers' Research Association which the Department of Scientific and Industrial Research made three years ago; but the important questions are nevertheless asked, and at least some indication given as to where the answers lie. Moreover, the ultimate value of the survey may well lie in its firm warning against facile generalizations. Generalizations covering the whole field of British industry regarding the use which is, or should be, made of scientists and technologists may be wholly unjustified.

Although there is no uniform pattern; however, the information collected affords fairly solid grounds for the belief that the extent to which industry in Britain makes the maximum use of the possibilities for scientific assistance depends directly on the outlook of the management at the head of each particular firm. The investigation revealed no evidence that scientists are, to any material extent, wastefully employed: there is no reference to wasteful employment practices, particularly in the engineering field,

that result in inefficient utilization of professional man-power, such as are deplored by the National Man-power Council in the United States in its report, "A Policy for Scientific and Professional Manpower", and have also been noted there by the American Society for Engineering Education and the National Society for Professional Engineers. Even if, on the contrary, there is no real justification for the belief that in Britain a shortage of scientists is the basic cause of any existing backwardness, difficulties in recruiting a really adequate supply of scientists for industry—of which the investigators noted some signs—are likely to discourage any failure to make the best possible use of those actually employed.

The dominant impression left by this study is that the attitudes of those directing the firms consulted is the decisive factor. Such changes as have come about in the past decade or two are the result of a changed 'climate' of thinking in the highest management circles. To that extent the inquiry confirms all that Dr. K. T. Compton said as to the importance of this climate of opinion in his address to the Parliamentary and Scientific Committee at its annual luncheon on February 18. The importance of higher technological education is very far from being limited to its direct effect on the supply of scientists or technologists: its influence permeates widely into society, and helps to develop the industrial and social climate in which technological progress and productivity can thrive.

It is worth noting in this connexion that the investigators found a surprisingly high proportion of science graduates occupying seats on boards of directors. Out of a total of 684 graduates employed in the firms visited, 93 were directors; and these were distributed over 70 of the 99 firms which were found to be employing graduates. Moreover, 74 of these graduates had reached this level by their own efforts, unassisted by family associations, but by way of positions involving day-to-day contacts with the firm's industrial, as distinct from purely research, activities. That position is perhaps more encouraging than might have been expected; but if in a high proportion of these firms direction of policy lies to some extent in the hands of scientifically trained men, the inquiry left the definite impression on the investigators that for those firms without qualified staff, as a whole, the services of a trained scientist or technologist capable of undertaking skilled supervision of processing efficiency would usually have been of real value.

The investigators recognized very clearly that no general criterion of satisfactory use of science in industry is available. Conditions vary too widely for any common standard to be applicable, and this to some extent must apply also to the nature and extent of the research conducted by a particular industry. That has its bearing on the work and functions of the research associations; and while the survey emphasizes the importance of the contribution of the research associations, it directs attention at the same time to the limitations of the research association movement and of the part the research associations can be expected to play in furthering

the use of science in industry. It is generally believed that, within their limitations, the work of the research associations is well done and is appropriate to the industry concerned. Such associations even now, however, do not cover the whole of industry, and the report suggests that they might with advantage increase their technical contacts with their member firms.

Too much must not be made of an investigation which at best is only a sample, and in which no scale of comparison elsewhere is possible. Nevertheless, the findings of the Manchester Joint Research Council, even though they rest on the personal judgment and experience of the investigators, suggest that any considerable expansion of the research association movement in Britain is a matter for careful forethought. No such expansion on the scientific research side is suggested in this report; but rather, increased effort in the technological and liaison work. The hope seems to be that by fostering a scientific outlook within the member firms, there may be a more effective application of existing knowledge and, apart from a better use of the facilities which research associations already provide, even a wider prosecution of research within the firm itself. The investigators seem to have no doubt in their own minds that such research is by far the most effective, however much it may draw on existing fundamental knowledge accumulated co-operatively in the research associations or at the universities.

A further encouraging feature of British industry revealed by this report is a much wider and closer contact with the universities than had been expected. This contact occurs in dealing with scientific or technical problems arising in actual production, where some new technique or particular experience available at the university may help to resolve a difficulty, rather than from consideration of the broader problems of training, recruitment or management research such as have formed the subject of conferences arranged between the Federation of British Industries and the universities. Nevertheless, it is true that more and better liaison is still required, and that there are ways in which the universities can assist in the further training of those who have already entered industry. However, the inquiry has revealed that immense resources of science are still untapped by industry and that more bridges between industry and science and greater mutual respect between the two are still prime needs in Britain; it has equally demonstrated that in certain fields British industry has most effectively enlisted already the resources of science. The investigators are right to condemn the unwarrantable depreciation of our achievements in discussing the use which British industry makes of science, with the attendant lowering of national prestige and discouragement of the coming generation of scientists and industrialists.

On the whole, the survey affords little support for the view, pressed rather strongly by Mr. John Edwards in the House of Commons at the second reading of the Development of Inventions Bill, that the resources of Great Britain are so distributed as to cause a lack of balance between those devoted to

fundamental research and those devoted to development. Mr. Edwards did not advocate any reduction in fundamental research, and neither does the present report; but the latter suggests that more effective channels of information rather than any considerable increase of development is the primary need. The functions of the National Research Development Corporation as a provider of risk capital, in any event, lie outside the limits which the Manchester investigators deliberately set themselves, and their comments on the activities of the Corporation are limited to the strong suggestion that the Corporation is not yet sufficiently widely known to play effectively the part it was created to fulfil.

How important or permanent that part may be is unlikely to be indicated by studies such as that which has just been carried out by the Manchester Joint Research Council. We need to know more as to the causes of relatively slow development in some sectors of British industry before a sound judgment is possible here. Light is likely to come from the detailed study of a few selected major research and development projects in which Britain is regarded as having lagged behind. Such an analysis, moreover, must take full account of those fiscal factors and restrictive practices which were excluded from this survey, and on which Sir Henry Tizard commented forcefully in his Messel Memorial Lecture a year or two ago. Financial and fiscal policies in themselves can easily form a climate of opinion, and encourage or discourage practices both on the part of employers and employed which are inimical to enterprise and the vigorous and uninhibited development of new ideas.

Few, if any, new ideas emerge from this report. It affords, so far as it goes, a notable amount of support for the existing structure for the organization of research in Britain, and shows very clearly that decisions to expand any particular sector should be taken not in isolation but in the light of full consideration of other claims on the country's resources, and in the light of the effect upon other sectors. For example, little interest was evinced in sponsored research; but the investigators suggest that there might be room for an institution of this character to work in the limited fields of chemical and electrical engineering. The major task, especially where industry is not yet making full use of science, is one of education. What aid science can bring to many branches of industry has not yet been expounded adequately from a point of view calculated to convince the ordinary business man. Liaison and education are needed to a far greater degree than more and better science.

The implications of this situation are not fully explored in this survey, nor indeed could they have been. There is evidence enough, to which reference has already been made, to suggest that we can await with some confidence the outcome of the slow process of persistent liaison and education from both sides, which the investigators themselves recognize as the policy likely to secure the best results, rather than a single act of policy either in the field of education or in industry. That, however, is an additional reason for

pressing forward, with more urgency than the Government has yet displayed, with the expansion of higher technological—as well as of technical—education, and with the formulation of a policy which gives full expression to the respective contributions of the universities, the colleges of technology, the technical colleges and the research associations themselves.

In that context the expansion of the research associations is likely to proceed in step with their appropriate place in the educational structure as well as the research organization of industry, and in providing that greater flow of information to industry not only from such bodies but also from the Department of Scientific and Industrial Research, the National Research Development Corporation and all those other varied sources of new knowledge such as the universities, the learned societies and the independent research institutions. The freer and fuller flow of information can contribute to the formation of a climate of opinion which both favours the acceptance of new ideas and the recruitment into industry of those competent to appreciate the significance of new knowledge and to apply it. "The ultimate responsibility for the use of scientific knowledge, as for the introduction of any sort of new idea, lies with the board of directors and the top level of management of each firm. The personalities of such men, and their attitudes to the scientific approach to their production, is therefore a matter of predominating importance." Any shortcomings of British industry in this respect are unlikely to be removed swiftly; but on the evidence of this report the whole trend is towards a position in which—except in firms whose routine activities involve little need of scientific knowledge—it will become increasingly rare to find in industry boards of managers on which no scientist finds a place.

THE BRITISH CONTRIBUTION TO MEDICINE

The British Contribution to Medicine

By Dr. Jaime Jaramillo-Arango. Pp. xii+220+45 plates. (Edinburgh and London: E. and S. Livingstone, Ltd., 1953.) 25s. net.

BEFORE entering the diplomatic service, Dr. Jaime Jaramillo-Arango was an eminent surgeon in the Republic of Colombia. He spent the period of the Second World War first as minister and then as ambassador of his country in Great Britain, and as a lasting souvenir of his mission and a tribute of admiration to the war effort of "this great nation", he decided to write an account of the "British Contribution to Medicine". The book was written in Spanish primarily for the benefit of medical men in the Latin-American countries. It must be a matter of surprise to the British reader how Dr. Jaramillo-Arango as an ambassador could have made himself so familiar with the details of much modern British medical research, as is apparently the case. This is where the attractive introduction written by Sir Arthur MacNalty is so useful, for it explains how closely the author entered into the life of medicine

in Britain, and not only visited universities, hospitals and laboratories but also attended medical and scientific societies and became friendly with many leaders of British medicine. There is good evidence in the book of these friendships in the descriptions of the life-history of some of the discoverers, which could only have been obtained from the individuals themselves. Personal knowledge of the research workers has also added greatly both to the factual account of the work described and to its interest, and has generally led to a better-balanced history of the work. Where the author seems to have had little or no contact with the active research workers in a particular field, as in the case of nutritional diseases, the account given is not quite so interesting and does not have the stamp of one so familiar with the subject.

Dr. Jaramillo-Arango picks out six medical discoveries of the past fifty years which he regards as almost exclusively the achievement of British medicine. These are anti-typhoid-paratyphoid inoculation, the discovery of penicillin, the role of the mosquito in the transmission of malaria, the discovery of paludrine, the discovery of vitamins, and the synthesis of stilboestrol.

The various chapters are written around these discoveries. Sometimes, as in the case of typhoid inoculation, penicillin, and the part played by the mosquito in the transmission of malaria, each British discovery forms a major part of a chapter. In others, the British work is rightly treated as an incident in the discussion of much wider problems; thus, the discovery of stilboestrol and, later in the United States, of its alleviating effect in cancer of the prostate, is placed in a comprehensive account of carcinogenesis and of the attempts to find curative agents of cancer. In this chapter, as might be expected, attention is given to the well-known work of Kennaway and Hieger and their colleagues at the Royal Cancer Hospital on the isolation of highly carcinogenic substances from tar.

It would be wrong to assume that British contributions even where, as in the case of penicillin, they dominate the picture, are allowed to monopolize any particular advance in knowledge. The author has endeavoured to place each major discovery in its proper setting. For example, in the chapter headed "The History of Antibiotics" all the salient discoveries are discussed, starting with Pasteur's observation in 1877 in which he showed the antagonism between the anthrax bacillus and the common aerobic bacteria, and finishing off with the most recent discoveries of terramycin and erythromycin. Detailed references are made to many outstanding figures who have participated in the development of knowledge in each field, and no limit in time or nationality excludes the mention of individual discoveries. Indeed, even experts in medical research will occasionally be surprised to read of unknown or forgotten observations and discoveries made in the past and in other countries concerning subjects of great current interest.

The book is well worth the attention of both the general reader with some basis of scientific knowledge and of the medical man. After all, it deals with a subject which has transformed human existence throughout the world during the past hundred years, and from this point of view challenges in importance any other scientific advance. Secondly, it is attractively written and can be read with much pleasure. It also gives an opportunity of seeing how well, in

the restricted field of medical research dealt with, British contributions stand in the eyes of a distinguished foreigner. To the British research worker it must afford an unusual experience of seeing some of the fruits of modern medical research in his country receiving adequate appraisal when placed in an international setting. The fact that the book was written primarily for foreign eyes gives it a special value as evidence of the high standing of our medical research. We owe a great debt of gratitude to Dr. Jaramillo-Arango for having undertaken this imaginative tribute to Great Britain, and in return must express our real appreciation of his scholarly and interesting book.

SCIENCE IN CRIMINOLOGY

Medical and Scientific Investigations In the Christie Case

By Dr. Francois E. Camps. Pp. xxiii + 244 + 6 plates. (London: Medical Publications, Ltd., 1953.) 30s. net.

RELATIVELY few criminal cases afford the opportunity for any extensive exercise in the forensic sciences. R. v. Ruxton and R. v. Haigh offered much in reconstruction data for identity, and R. v. Dobkin had the added interest of dental detail of exceptional quality and of evidence as to the cause of death. The recent case of R. v. Christie has renewed interest in these problems—in methods of ageing, sexing and height estimation in human remains, in the detection of a cause of death after a long interval of time, and the ever-difficult problem of determining the lapse of time since death. It also provided another problem—how to present such evidence at court in the most easily assimilable form: science must be made both reasonable and palatable to lay juries.

This record by Dr. F. E. Camps of the evidence in R. v. Christie is not so much his work as that of a team of experts whose specialities—microscopy, analytical chemistry, mycology, dental histology, anatomy, radiology and Dr. Camps's own forensic pathology—combined to forge the links in the evidence presented by the Crown for the prosecution in corroboration of the statements of admission of guilt made by the accused. Like all edited books, it lacks a uniformity of style and reveals both talent and mediocrity in prose-writing. It is in the content of scientific data that its chief attraction lies.

The most polished pieces of work are undoubtedly those of Prof. A. E. W. Miles on the study of the teeth and of Dr. Richard Harrison on the anatomical problems of sexing, ageing and giving stature to the skeletal remains: each is excellently illustrated and well tabulated. Gustafson's modern 'points method' for ageing teeth and of using incremental patterns to assign them to individuals receives some further support, and the superiority of the formulae of Trotter and Gleaser for stature-estimates over the older Rollet, Pearson or even Dupertuis and Hadden formulae is amply reflected: older tables all showed a tendency to under-estimation. Incidentally, it is to be noted that neither Dr. Camps nor his dental advisers seem to have read the descriptions of 'pink teeth' in the dead by both Thomas Bell in 1829 or of his pupil, the famous Tomes, for they study at some length the nature of the 'new observation', now more than a century old; little, indeed, is new when one comes to search the literature.

A chapter on the known facts of coal-gas absorption factors by the Gas Board expert, F. O. Smith, tends to elaborate somewhat tediously the standard writings on the subject; but one must remember that this book is plainly intended for interested lay consumption as well as medical and scientific. Major H. A. Dade records the surprisingly restricted mycological findings of the intact bodies—almost entirely of common and ubiquitous moulds—*Mucor racemosus* Fresen, *Penicillium cyclopium*; it would have been of interest to have recorded the temperature-ranges for growth of these moulds.

The book is completed by the addition of Christie's three statements, which afforded a great deal of 'testing evidence', and of a short account of the Scott Henderson inquiry which followed public outcry over the prior execution of Evans who had lived with Christie at a material time.

Anyone interested in the application of scientific knowledge to the needs of the law in criminal investigation will find much of interest here: it is a good example of the demands for team-work which occasionally arise in the course of a practice in forensic medicine and criminology, and Medical Publications, Ltd., have made an excellent job of reproduction and illustration on first-class paper. It is not to be recommended to the amateur sleuth, the writer of detective thrillers or the morbidly curious, for it is a serious scientific account of laboratory and field-investigations.

KATH SIMPSON

POISONOUS PLANTS OF INDIA

Poisonous Plants of India

Vol. 1. By Sir Ram Nath Chopra, Rattan Lal Badhwar and Prof. Sudhamoy Ghosh. (The Indian Council of Agricultural Research: Scientific Monograph No. 17.) Pp. liv + 762. (Delhi: Manager of Publications, 1949.) 30 rupees.

ALTHOUGH the title-page is dated 1949, this book has only recently appeared after a 'labour' which has lasted about fourteen years. The manuscript was sent to the press at the beginning of the Second World War; but owing to vexatious delays due to shortage of paper, and for other reasons, the first volume did not leave the printers' hands until 1949. Shortly after it appeared, the volume was recalled for some correction and has only lately been issued to the public. The welcome which it is sure to receive will be some recompense to the authors for their frustration.

In their preface the authors state that it is their aim to survey the whole field of poisonous plants in India from the botanical, chemical, pharmacological and economic angles. This aim has been achieved; but it is open to question whether it would not have been better to exclude a great deal of the botanical matter. Botanists who use the book will not be interested in the botany as such, for which they have other sources, and non-botanists will only be interested in the plants and their products.

This is only a trifling criticism; but the size of the book might have been considerably reduced without sacrificing any of the really important matter in it—which is undoubtedly the account of the poisonous products contained in the tissues of the plants themselves. The information given on this subject is thorough and reasonably up to date, although much work on poisonous drugs found in

Indian plants must have been done since the manuscript of the book went to press fourteen years ago. The authors, in their desire for completeness, even go so far as to describe the symptoms and treatment of persons suffering from poisoning.

Although a great deal of information is given about a large number of species, it is surprising to note the number of plants which are "reported" or "said" to contain poisonous principles, and upon which no work has yet been done. This is a measure of the task which lies before Indian chemists and pharmacognosists during the years to come.

The book is illustrated by a number of line-drawings of very unequal merit. Some of them are reasonably good, while others are quite unworthy of a book of this importance: some are from works fifty years old, while others have come from books published a hundred or even a hundred and fifty years or more ago. A serious defect in the illustrations is that in no instance is there any indication of the size of the parts illustrated, or even what these parts may be, although a number of the blocks contain dissections. If it is thought necessary to have illustrations, then these should be good. The binding is quite inadequate for a book of this weight (4 lb.) and will definitely not stand up to the very frequent occasions on which the volume will be consulted.

The authors are to be congratulated on a really useful book, which for many years to come will be indispensable to all medical and botanical libraries as a work of reference.

N. L. BOB

TURBULENT MOTION OF FLUIDS

The Theory of Homogeneous Turbulence

By Dr. G. K. Batchelor. (Cambridge Monographs on Mechanics and Applied Mathematics.) Pp. xi+197. (Cambridge: At the University Press, 1953.) 25s. net.

TO obtain some understanding of the 'turbulent' motion of fluids (a term first used by Kelvin) has been one of the outstanding problems of the physical sciences since 1883, when Osborne Reynolds initiated the subject in a series of brilliant papers. In the succeeding age, when the problems most discussed by physicists were on the atomic and sub-atomic scale, the problem of turbulence remained a notable exception and continued to excite the imaginations of the most eminent students of the physical sciences. Werner Heisenberg, for example, has constantly returned to the subject from his better-known researches in quantum theory, and Rayleigh, Sommerfeld and Kolmogorov all made contributions. Ludwig Prandtl, the creator of the modern dynamics of fluids, who died recently, and his pupil von Kármán, have been important influences at all stages of the work. But perhaps the most single-minded, and successful, of the many warriors assailing the dragon has been G. I. Taylor who, though approaching his seventieth birthday, is still extremely active in the fight. After tackling the problem from many different and valuable points of view, he initiated in 1935 a new approach. Recognizing at last that all the methods based on the conventional ideas of statistical mechanics were doomed to failure, he developed a statistical theory of turbulence founded on the recognition that fluids behave like continua, with the statistical correlation coefficient between the fluid velocities at two nearby

points as the fundamental observable. Later he demonstrated the relation of this correlation to the spatial spectrum of turbulence.

The new methods have been applied principally to the particular case of 'homogeneous' turbulence—that is to say, turbulence the statistical properties of which do not vary from point to point. The difficulties of extending them to non-homogeneous turbulence appear formidable; but the qualitative ideas suggested by the statistical theory, and wind-tunnel results, for homogeneous turbulence are already useful in all problems of turbulence. Since the Second World War, progress in homogeneous turbulence has been nowhere so great as in Taylor's own research group in the Cavendish Laboratory, Cambridge, led by G. K. Batchelor and A. A. Townsend. In the circumstances, no one could have been more suitable than Dr. Batchelor for giving a complete account of the present state of knowledge of the subject, and he has succeeded admirably in the book under review. Developing the subject in a logical order, he makes the reader thoroughly familiar with all the detailed correlations and spectra and their simpler, purely kinematical properties, before advancing to the problem of the general dynamics of decay, where one must make use of the fact that each realization of the velocity field satisfies the momentum equation of Stokes and Navier. The need for additional postulates like the 'local similarity' theory of Kolmogorov and the quasi-equilibrium theories of later authors is clearly shown, and these theories are critically explained. The probability distributions of the velocity and its derivatives are described, with physical inferences about the smallest-scale features of turbulence, and the use of the hypothesis that mean products of four velocities are related to mean products of two as for quantities obeying a joint normal distribution law, is illustrated by the calculation of the pressure correlation function. The bibliography is comprehensive, and the general layout of the book (the first of a new Cambridge series) makes for easy and pleasant reading. The dedication is "To G. I."

If, less than two years after the book was completed, the subject has moved on, this is due almost entirely to further work in the Cavendish Laboratory by Dr. Batchelor, Dr. Townsend and their associates. If the book were being re-edited, much less would be said about the general tendency to isotropy of homogeneous turbulence, which seems to be unsubstantiated for the eddies containing most of the turbulent energy. The theory that the joint distribution of velocities becomes normal in the final period of decay, so that different spectral components of the velocity are statistically independent, seems untenable because the different components each decay exponentially in that period, conserving whatever statistical dependence they may already have. Again, the theory of the 'permanence of big eddies' is currently being questioned. Dr. I. Proudman has calculated the sound field which isotropic turbulence generates.

All the time, in fact, the extent of our pitifully small understanding of turbulent motion is increasing. If all students of the subject make themselves thoroughly familiar with the material of Dr. Batchelor's book, so that they obtain a clear idea of the established knowledge without being encouraged to gloss over any real difficulties or unsimplifiable intricacies, then one may expect future progress to become faster still.

M. J. LIGHTHILL

Electrodynamics

(Lectures on Theoretical Physics, Vol. 3.) By Arnold Sommerfeld. Translated by Edward G. Ramberg. Pp. xiii+371. (New York: Academic Press, Inc., 1952.) 6.80 dollars.

FOUR of the six volumes in the German edition of Prof. A. Sommerfeld's "Lectures on Theoretical Physics" have been reviewed by Prof. R. E. Peierls (*Nature*, 168, 887 (1951); also 170, 684 (1952)), who regarded them as representing "an almost perfect choice of topics for a basic course on theoretical physics" and eagerly awaited an English translation of the series. The translation by E. G. Ramberg of Vol. 3, "Electrodynamics", fully justifies Prof. Peierls's enthusiastic comments.

This book is divided into four main parts. Maxwell's equations in vectorial integral form are the starting-point of the theory in Part 1, and the electromagnetic phenomena are derived from them systematically by deduction in Part 2, which constitutes the main portion of the volume. Special relativity and the Lorentz theory of the electron are covered fully in Part 3, and the electrodynamics of moving media is developed in Part 4. The book concludes with a selection of problems, together with answers and very helpful comments. The subject is presented in such a manner as to stimulate thought, many of the topics being originally developed by Sommerfeld and his school at Munich. The parallel nature of the magnetic induction B and the electric intensity E is stressed; they are classified as "entities of intensity", whereas the electric displacement D and the magnetic intensity H are "entities of quantity".

It is unfortunate that the book is unsuitable for use as a text-book in a third-year honours course in physics, since several topics usually associated with the subject are found in the other volumes of the series, to which many references are made. The book will, however, form a very useful reference book for advanced students.

Journey Into Wonder

By N. J. Berrill. Pp. 320. (London: Victor Gollancz, Ltd., 1953.) 13s. 6d. net.

"THE power of thought is not knowledge alone, it is the thrust of intellect as it selects this and that feature from the chaotic accumulation and builds them swiftly into a coherent pattern." So writes Prof. N. J. Berrill when viewing the limitations as a chronicler of the seventeenth-century adventurer and explorer, William Dampier. The ability to select and build from a vast accumulation of knowledge is clearly possessed by Prof. Berrill himself to a marked degree. From the accounts of the voyages of Columbus, the medieval mystic searching for the Indies and the Garden of Eden, to the harassing journeys in the Antarctic of Shackleton and Scott, he has constructed a most coherent and absorbing account of the natural history of the world's great voyages of exploration. Not only are the discoveries of the naturalist explorers such as Darwin and Humboldt, or the Forsters who accompanied Captain Cook, included, but also many interesting though unexpected observations by the buccaneers, Drake and John and Richard Hawkins.

This book, however, is much more than a judicious selection of other men's writings. It is a synthesis, containing many intriguing speculations based on the observations made by these explorers. Prof. Berrill

throws new light, for example, on the probable location of Columbus's first landing after crossing the Atlantic, gives a masterly summary of the evidence for the origins of the Polynesian race from the east and so dismisses the theory which inspired the remarkable Kon Tiki expedition, while one of his most interesting discussions is on the origin and evolution of penguins. Prof. Berrill writes with a light hand and a puckish humour which makes his "Journey into Wonder" quite wonderful. ALAN J. BROOK

Report of the Thirteenth International Horticultural Congress 1952; London, 8-15 September Vol. 1: Pp. xv+576+39 plates. Vol. 2: Pp. viii+577-1297+plates 40-100. (London: The Royal Horticultural Society, 1953.) 42s. the set.

THE Thirteenth International Horticultural Congress was held in London during September 8-15, 1952, and some of the principal contributions were reviewed in these columns shortly after the Congress (*Nature*, 170, 647; 1952). The full text of all the papers, which has now been published, makes a valuable symposium on modern horticultural problems, both practical and scientific.

Much space is devoted to the international code of nomenclature for cultivated plants, which is printed in full. The text of ten general lectures makes a valuable summary for those who have but limited time to follow the latest developments. For readers who require greater detail, there are sections on fruit growing, vegetable growing, ornamental plant growing, plant diseases and purity of stocks, on plant breeding, environmental control and on seeds. Tropical and sub-tropical horticulture is given a special section, while special symposia on citrus problems and on botanic gardens meet very specialized needs.

The hundred half-tone plates in the two volumes are of excellent quality, and very numerous line-diagrams enrich the text. The papers are published in English, French or German, but all have summaries in English and French. Scientific developments in horticulture are now taking place with such rapidity that it is scarcely possible for one individual to review, by normal methods, more than a part. An international congress brings an outstanding opportunity to review the whole, to digest the knowledge and bring it within the range of the teacher or grower, and to take stock of it. The volumes now published are worthy of the occasion.

JOHN GRAINGER

Roger Bacon In Life and Legend

By E. Westcott. Pp. 140. (London: Rookliff Publishing Corporation, Ltd., 1953.) 10s. 6d. net.

A SHORT life of Roger Bacon is an undoubted need; but the present work will not do much to fill it. The author has tried to give a straightforward account and has no axe to grind; but he would seem to be unqualified to attempt the far from easy task of presenting the facts of Bacon's life and assessing the value of his work. The book is a derivative one and is largely based on the ninety-year-old biography of Emile Charles, together with some material derived from other works of varying status. The recent great developments in the study of medieval science have passed the author by. This would matter less if the work were clearly presented; but in fact it is incoherent and confused, with not a few mis-spellings of Latin titles and proper names.

F. SHEERWOOD TAYLOR

JUBILEE OF THE UNIVERSITY OF LEEDS

By PROF. D. G. CHRISTOPHERSON, O.B.E.

THE University of Leeds received its Royal Charter on April 25, 1904. Before that date, as the Yorkshire College, it had since 1887 been one of the three constituent colleges of the Victoria University, the other two being Owens College, Manchester, and University College, Liverpool.

At the time, there were some doubts whether the College, which dated its original foundations only from 1874, would be able to stand on its own feet as an independent university. The Yorkshire College was the last of the three to present a petition for a Royal Charter, and the delay is a measure of the relative unwillingness of the College to cut adrift from the parent University.

In the upshot, from the beginning, these fears appear to have been largely groundless. Progress, although limited by lack of funds at least until the relative bounty of the years following the Second World War, has been steady. In 1904, there were twenty-seven professors, and approximately the same number of Departments. After the First World War, this number had grown to thirty-three. It is at present sixty-six. Student numbers have increased in about the same proportion. In 1949, the year in which the post-war bulge reached its maximum, there were 3,336 students, and it was supposed that when the demand from the ex-service men had been met, there would be a substantial recession. This has not happened, the number this year being 3,267. University building has also proceeded steadily: the immediate pre-war years saw the erection of the Brotherton Library, and the University Union, both now substantially overcrowded but still among the best of their kind in the civic universities of Britain. Since the War, the large and handsome Parkinson building has been completed, and a spacious new refectory which it is hoped will do much to relieve the strain upon the Union and to assist the social and cultural life of the University is nearing completion.

Developments on this scale bring their own problems, not all of which are financial. The founders of civic universities and colleges in recent times have usually had to choose at the outset between two alternative policies. They could select a site near the centre of their city, which would have great practical advantages from the point of view of convenience of access, and perhaps also, less tangibly, in fostering a greater feeling of interdependence and mutual understanding between the university and the city. Alternatively, the university could be put well outside the built-up area, where room for expansion could be easily acquired when needed, where in many cases the conditions of life were pleasanter, and where a sense of detachment could be more easily cultivated. True, a larger share of resources would then have to be devoted to building halls of residence for students; but many would take the view that this is in itself an additional point in favour of a policy of building outside the city. The founders of the Yorkshire College may have felt that in placing the College on the edge of what was then the continuously built-up area they were adopting the best compromise between these two policies. In practice, due to the enormous growth of the city over the past seventy years, they were

following the former. Their successors have succeeded to a striking extent in resisting the centrifugal tendency which a crowded site invariably produces. The University has been kept together, but at the price of severe congestion on the present site. Looking forward into the future, it can be discerned that after another fifty years much obsolescent housing will have vanished, the pall of industrial smoke which all too often covers the city will have been dispelled, and the University will be found to occupy the ideal situation, near enough to the centre to form a real part of civic life and society, compact enough for its essential unity to be apparent in every Department and to every student, and yet with enough free space for the various buildings to be reasonably sited without undue congestion. In the meantime, although no opportunity of pushing back the frontiers has been missed, progress towards adequate living-space has often seemed slow.

The Jubilee celebrations will no doubt be principally an expression of confidence in the future; but they will not be without a note of pride in the past. There is no space in this article to refer to many of the distinguished men who at various times have contributed to the academic life of the University. Exception can be made for three names only. In the years before the First World War, it was at Leeds that the Braggs achieved their classical researches on the X-ray spectrometer; in a long tenure of the chair of chemistry, Smithells built up a Department of Chemistry which has remained outstanding through the whole fifty years of the University's life; as vice-chancellor for the years 1911-23, Sir Michael Sadler did so much to broaden the purpose of the modern universities, and to achieve a synthesis of the traditions of the ancient universities and the dynamism of the new, that he can be said to have exercised a decisive influence on the history of university education in Great Britain.

Leeds has always been strong in the field of applied science. The Yorkshire College had Departments of Agriculture, Engineering, Textile Industries, Colour Chemistry, Leather Industries and Mining. The Department of Coal Gas and Fuel Industries was added in 1908, and now includes Chemical Engineering and Metallurgy. The link between these Departments and the Departments of Pure Science is very strong. Almost all technological students spend a large part of their time in the first two years of their course in the appropriate Science or Mathematics Departments, and all courses are controlled by a joint Board of the Faculties of Science and Technology. In this field, to which so much public attention has been given in recent years, the University of Leeds feels that it has an especial, perhaps a unique, experience.

The long history of technology at Leeds, however, carries with it one drawback—that all the technological departments, with the exception of the Department of Mining, are now housed in relatively old quarters, several of them in the original buildings of the Yorkshire College. As a first step in overcoming this difficulty, the Department of Textile Industries, with very substantial financial support from the industry, is going ahead with the erection of a rayon technology building. The next major item in the

development programme envisages the beginning of a new block to the north of the present site, which will provide new quarters first for the Coal Gas and Fuel Industries Department and afterwards for the engineering departments.

Fifty years is a short time in the life of a university. Compared with the slow evolution which went on through the preceding centuries, the changes which have taken place in the twentieth century are extraordinary. (But it must be borne in mind that much larger institutions have been evolved in the same time in the United States.) The question naturally arises as to whether the foundation of a university is simply a matter of material resources—money must be spent, and buildings erected, and a university will be found to have been created—or whether there is something vegetable about its growth. Many able and intelligent men—or perhaps many generations of able and intelligent men—must give their life's work before the accumulation of inherited wisdom and experience implied in the title of university can be built up. What is unseen, in academic standards, in understanding of the needs of undergraduates, in the immensely important but unpublicized field of relations between schools and universities, is more important than what can be seen and counted in buildings and departments. It may be that Leeds, in common with other relatively recent foundations, has still to complete its education in these subjects. But in fifty sessions, awareness of these intangible factors has grown continuously, and the University looks forward to its next half-century with a confidence based not only on the substantial material resources which have been built up, but also on an ever clearer conception of the purpose of a university and its place in contemporary society.

CRYSTALLINE CYTOCHROME *b*, AND LACTIC DEHYDROGENASE OF YEAST

By C. A. APPLEBY and Dr. R. K. MORTON

Department of Biochemistry, University of Melbourne,
Australia

FOLLOWING the re-discovery of cytochromes by Keilin¹, a number of different members of this important group of intra-cellular haem-proteins has been described on the basis of their absorption spectra. Particular interest is attached to cytochromes of the *b* group, that is, cytochromes *b*, *b*₁, *b*₂ and *b*₅, some of which appear to be intimately associated with certain enzyme systems. Thus, cytochrome *b* appears to be closely linked to the succinic dehydrogenase system of animal tissues, plants and certain bacteria, and it has been claimed that this cytochrome is identical with succinic dehydrogenase in *Corynebacterium diphtheriae*². Dixon and co-workers³⁻⁵, in classical studies of the lactic dehydrogenase system of yeast, found that a haem-protein which they called cytochrome *b*₂ was an essential component of this enzyme system. Although considerable purification was achieved, marked instability of the most active preparations prevented conclusive demonstration as to whether the cytochrome was the dehydrogenase (that is, the enzyme which reacts directly with the substrate) or an

essential intermediate carrier acting between lactate and the electron acceptor (methylene blue in these studies). Yeast lactic dehydrogenase is one of a small but important group of 'cytochrome *b*-linked' dehydrogenases. Since the relationship between cytochrome *b*₂ and lactic dehydrogenase has considerable bearing on views as to the nature of the enzymes of this group, we have re-examined this enzyme system of baker's yeast.

Lactic dehydrogenase activity has been determined spectrophotometrically when using potassium ferricyanide or cytochrome *c* as electron acceptors. When measuring the rate of reduction of methylene blue, we have used the Thunberg tube method⁶. Extensive preliminary studies confirmed the observations of Dixon and associates³ that cytochrome *b*₂ accompanied the lactic dehydrogenase activity throughout many different purification procedures. Moreover, the cytochrome *b*₂ was rapidly and completely reduced by the addition of lactate to active enzyme preparations. In preparations which had lost most of their dehydrogenase activity following storage, the cytochrome component was still completely, although slowly, reduced by lactate. The cytochrome *b*₂ of inactive enzyme preparations was no longer reducible by lactate, although completely reduced by dithionite. Thus, it seemed likely that the cytochrome *b*₂ was not involved in the direct reaction with lactate. Attention was therefore given to methods for complete purification of the enzyme system.

By treatment of the yeast with *n*-butanol, essentially by the method previously described by the senior author⁷, the enzyme was dissociated from accompanying lipid material which is probably of mitochondrial origin. Subsequent purification procedures, which will be described in detail elsewhere, yielded clear extracts containing the dehydrogenase activity as well as cytochromes *b*₂ and *c*. From such extracts the enzyme was eventually separated as well-formed crystals. The first crystals obtained are shown in Fig. 1. These were allowed to develop slowly and are therefore relatively much larger than those which were grown rapidly from recrystallized material and which are also illustrated. The crystals show only weak anisotropy. They are readily soluble in suitable dilute buffers at neutral pH values.

Enzymic Properties of Crystalline Lactic Dehydrogenase

The best crystalline preparations have an activity of approximately 7,000 units (μmoles ferricyanide reduced/hr./mgm. dry weight) at 20° C. and at optimal pH (8.0). With methylene blue at pH 5.2, using a reduction time of approximately 10 sec., the same preparations have activities of 740 units (μmoles methylene blue reduced/hr./mgm. dry weight) at 20° and 2,100 units at 38° C. The corresponding *Q_{MB}* values (as defined by Bach *et al.*⁸) are 16,500 and 47,000 at 20° and 38° C., respectively, and hence the crystalline enzyme is about fifteen times as active as the best preparations (*Q_{MB}* 3,000 at 38°) obtained by the earlier workers⁴.

Bach *et al.*⁸ observed that crude extracts containing the enzyme rapidly reduced cytochrome *c*, and determined the rate of reduction of cytochrome *c* manometrically in the presence of excess cytochrome oxidase. During the course of purification of the enzyme, they found that the rate of reduction of cytochrome *c* became considerably less than that of



Fig. 1. Crystalline cytochrome b_1 from baker's yeast. The initial crystals are shown in the upper photograph (a) and twice recrystallized material in the lower (b). Both photographs taken using phase-contrast. $\times 260$

methylene blue. Nevertheless, spectroscopic observation showed that their purest preparations could still reduce cytochrome c .

By direct (spectrophotometric) measurement of the rate of cytochrome c reduction during the course of purification, we have found that the rate of reduction of cytochrome c is undiminished as compared with reduction of both ferricyanide and methylene blue. The same proportionality with the three different electron acceptors is found in enzyme which has been twice recrystallized. The best preparations have an activity of approximately 1,800 units (μ moles cytochrome c reduced/hr./mgm. dry weight) at 20°C . and at pH 7.0. The reduction of a molecule of cytochrome c or of ferricyanide involves only a single electron transfer, whereas reduction of a molecule of methylene blue involves two electrons. Hence it is seen that, at 20°C ., the rates of reduction of cytochrome c (1,800 units) and of methylene blue (740 units) are of similar order of magnitude but about four to five times less than that of ferricyanide (7,000 units).

The reduction of cytochrome c by the crystalline enzyme was not inhibited by 'Antimycin A' ($1.5 \times 10^{-4} M$), which specifically inhibits the reduction of cytochrome c by the succinic dehydrogenase system of animal tissue homogenates⁷. However, a partially purified preparation of the lactic dehydrogenase was 90 per cent inhibited by *p*-chloromercuribenzoate ($10^{-3} M$) when tested with ferricyanide as electron acceptor. This suggests that certain —SH groups

are necessary for enzymic activity, as in the case of succinic dehydrogenase⁸.

Physical Properties of Crystalline Lactic Dehydrogenase

Crystals of the enzyme are distinctly pink in colour, while concentrated solutions are brown-coloured when oxidized and coral-pink when reduced with either lactate or dithionite. The oxidized enzyme shows little or no absorption in the visible region of the spectrum, but the reduced enzyme shows strong absorption bands at 556.5 $m\mu$ (α -band) and 525 $m\mu$ (β -band) as determined using a Hartridge reversion spectroscope. These bands correspond with those previously described for cytochrome b_1 by Dixon and co-workers⁴. Both absorption bands were intensified by freezing in liquid air as described by Keilin and Hartree⁹, and the α -band was shifted to 555.2 $m\mu$, while there was no observable change in the position of the β -band. The crystalline enzyme appears to be completely free from cytochrome c .

The absorption spectrum of the crystalline enzyme as determined in the Beckman spectrophotometer is shown in Fig. 2. The oxidized enzyme (curve A) shows a parahematin-type spectrum, with general absorption in the region of 550 $m\mu$ and with bands at 418 $m\mu$ (Soret) and 359 $m\mu$. There is a pronounced absorption band in the ultra-violet region, with peaks at 263 $m\mu$ and 257 $m\mu$. Curve B shows the spectrum of the enzyme reduced with lactate. The positions of the absorption bands are as follows: α , 557 $m\mu$; β , 528 $m\mu$; γ (or Soret), 424 $m\mu$; δ , 330 $m\mu$. The absorption in the ultra-violet region is similar to that of the oxidized enzyme. These curves may be compared directly with those of cytochrome c as obtained by Margoliash (see Keilin and Slater¹) and of cytochrome f (Davenport and Hill¹⁰), both of which have been highly purified but neither of which has so far been obtained in a crystalline form. It is clear, therefore, that lactic dehydrogenase activity and cytochrome b_1 are intimately associated in the crystals. Moreover, in confirmation of the observations of Dixon and co-workers⁴, there is a direct relationship between the concentration of cytochrome b_1 and lactic dehydrogenase activity as determined in several different crystalline preparations and after recrystallization.

Prosthetic Groups of Lactic Dehydrogenase

The absorption spectrum of the pyridine haemochromogen of the crystalline enzyme was determined in the Beckman spectrophotometer and found to be identical with that of the pyridine haemochromogen from a pure sample of hemin. This confirms the finding of Dixon and associates⁴ that protohem is the haem group of cytochrome b_1 , and protohem must also now be considered as a prosthetic group of lactic dehydrogenase.

A sample of enzyme which had been twice recrystallized was denatured by heating to 100° for 2 min. at pH 6.8. An equal weight of ammonium sulphate was added, and the brown protein precipitate was removed by high-speed centrifuging. The clear supernatant was a pure green colour and showed a strong fluorescence typical of riboflavin. The flavin was extracted into phenol, transferred to water, and then compared with authentic samples of flavin adenine dinucleotide, riboflavin-5'-phosphate (flavin mononucleotide) and riboflavin, using paper

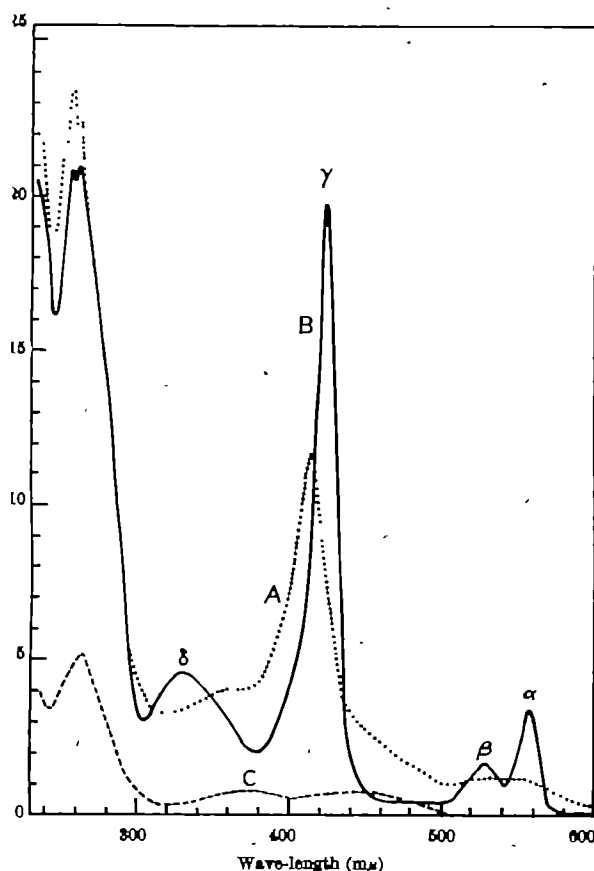


Fig. 2. Absorption spectrum of crystalline cytochrome b . Curve A, oxidized; curve B, reduced with lactate; curve C, supernatant obtained by heat denaturation of enzyme. Curves are given at cytochrome concentration equivalent to 10^{-4} M-haemin. α , β , γ and δ denote absorption bands of the reduced cytochrome

chromatography. In two different solvent systems (*n*-butanol-acetic acid-water, and pyridine-*n*-propanol-water)¹¹, the unknown flavin moved as flavin mononucleotide. There was no flavin adenine dinucleotide in the enzyme extract. It is therefore tentatively concluded that the flavin is flavin mononucleotide.

The absorption spectrum of the flavin obtained by heat-denaturation of the enzyme, at the same concentration as for curves A and B, is shown in Fig. 2 as curve C. The spectrum is identical with that of flavin mononucleotide except for somewhat increased absorption in the ultra-violet region, probably due to some protein denaturation products. The contribution of this flavin to the absorption of the enzyme in the region 300–600 mμ is apparently small, since the oxidized enzyme (curve A) shows no clear indication of absorption in this region which could be attributed unequivocally to the presence of the flavin. It is possible that the decreased absorption of the reduced enzyme at 445 and 373 mμ (the absorption maxima of flavin mononucleotide) may be partly due to the reduction of the flavin by lactate, but the difference spectrum (oxidized minus reduced enzyme) is not the spectrum of flavin mononucleotide. The most noticeable contribution of the flavin (which, like the mononucleotide, has a peak at 286 mμ) to the absorption of the enzyme is undoubtedly in the ultra-violet region. The apparently small influence of the flavin on the spectrum of the oxidized enzyme

in the region 300–600 mμ may possibly be produced by modification of the flavin absorption due to combination with the protein.

The flavin group is completely bound to the enzyme, and normally none is dissociated, since freshly prepared solutions of the crystals show no flavin fluorescence. However, this always develops on storage at 0° and is increased by dialysis. The appearance of fluorescence due to free flavin is associated with decline of enzymic activity, and there is a relationship between the amount of fluorescence, as judged by visual examination, and the extent of decline in activity. It is therefore apparent that the flavin is directly concerned in the activity of the enzyme, and hence flavin mononucleotide must be regarded as a prosthetic group.

Nature of Lactic Dehydrogenase

Electrophoretic examination of twice-crystallized material has been carried out in a Tiselius-type apparatus, using 1 per cent protein in phosphate-lactate buffer, pH 7.05, ionic strength 0.25. One component, in very small amount, moved rapidly away from the main material. This was afterwards identified as free flavin, which had apparently dissociated during dialysis (40 hr.), but had not attained equilibrium with the buffer system. The protein component, however, appeared as a single peak, which remained symmetrical for more than three hours, although some asymmetry developed after five hours. This preliminary result, therefore, strongly supports other evidence that the crystalline enzyme consists of a single protein.

While further studies of the physical and chemical properties of the crystalline material are in progress, the evidence so far available strongly indicates that yeast lactic dehydrogenase is a single protein with two different prosthetic groups. Despite many attempts, we have not so far been able to isolate a separate, active flavoprotein from cytochrome b . The possibility that the flavin group is associated with an adsorbed contaminant is further excluded by the fact that, while cytochrome c and other inactive material remain in the supernatant at the initial crystallization step, the flavin as well as the cytochrome b , is almost wholly removed from the mother liquor with the crystals. The constant proportion of one haem group to one flavin group, as found in the initial crystalline product and after two further recrystallizations, also indicates that both groups are associated with the one protein. Moreover, the total purification, as compared with the initial yeast on a dry-weight basis, is at least 7,000-fold, while a tenfold purification is achieved in the crystallization step. Despite this considerable evidence in favour of homogeneity of the enzyme system, we are continuing efforts to resolve it into more than one active protein.

In the case of a single protein with two prosthetic groups, it becomes somewhat artificial to distinguish between the 'dehydrogenase' and the 'electron-carrier'. However, the two groups presumably are concerned with different functions, and we incline to the view that the flavin mononucleotide group, rather than the protohaemin, acts as the direct acceptor of electrons from lactate. Dissociation of the flavin mononucleotide group appears to be irreversible, and partial dissociation or interference with this group would account for decline or loss of

ability to reduce the protohaemin by lactate, whereas it would still be reducible by dithionite. 'Dehydrogenase' activity thus appears to be dependent on the flavin group, and 'electron-transfer' on the protohaem group. It is noteworthy that the cytochrome *b*₅ of inactive, oxidized enzyme is completely reduced by the addition of lactate together with a small amount of active lactic dehydrogenase.

Yeast lactic dehydrogenase is the first of the 'cytochrome c-linked' dehydrogenases to be highly purified. It is of especial interest in that it is itself a cytochrome, being the first of the *b* group to be considerably purified and the first cytochrome to be obtained in crystalline form. It appears to belong to a new class of enzymes not hitherto described, and may well be unique. However, evidence recently obtained with partially purified heart-muscle succinic dehydrogenase⁴ also indicates that this enzyme is dependent for activity upon a flavin group, and in this respect resembles yeast lactic dehydrogenase. It would seem quite possible that the other known 'cytochrome c-linked' dehydrogenases, namely, mitochondrial α -glycerophosphate dehydrogenase of skeletal muscle, liver choline dehydrogenase, and the malic dehydrogenase systems of certain yeasts and bacteria, are similar flavoproteins.

We wish to thank Mr. Barrett, of H. Hudson and Co. Pty., Ltd., for his helpful co-operation and for the generous gift of yeast for this investigation. We are grateful to Mr. J. Pye, of the Walter and Eliza Hall Institute for Medical Research, for carrying out the electrophoretic examination of the enzyme for us. Dr. M. Dixon suggested this problem to the senior author (R. K. M.), who commenced the investigation at the School of Biochemistry, University of Cambridge, and has continued it at the University of Melbourne. One of us (C. A. A.) is seconded from the Division of Plant Industry, Commonwealth Scientific and Industrial Research Organization, Canberra.

[Jan. 21.]

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⁶ Morton, R. K., *Nature*, **165**, 1092 (1950).

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⁸ Slater, H. C., *Biochem. J.*, **45**, 180 (1948).

⁹ Kellin, D., and Hartree, E. F., *Nature*, **164**, 254 (1949).

¹⁰ Davenport, H. M., and Hill, B., *Proc. Roy. Soc., B*, **129**, 217 (1952).

¹¹ Crammer, J. L., *Nature*, **161**, 249 (1948). Whitby, L. G., *Biochem. J.*, **50**, 433 (1952).

existing procedures. It has, however, been clear for some time that many unusual considerations must be taken into account in assessing the potentialities of the method and that the necessary experimental evidence is only partially available, if at all. Although many features are therefore in doubt, sufficient factual information has recently been felt to be available in Britain to provide the basis for a short symposium, and such a meeting was held in Cambridge on February 10 by the Food and Microbiology Groups of the Society of Chemical Industry.

Dr. W. Wild opened the symposium with a discussion of the general properties of ionizing radiations and possible methods of producing them. Suitable sources fall into two groups: electrical generators delivering high-speed electrons or, less probably, X-rays; and radioactive sources giving electrons (β -rays) or electromagnetic radiation (γ -rays). Generators would be the more feasible source for large-scale work during the next decade, and several types might be considered, including Van de Graaff, resonant transformer and impulse generators, and travelling-wave linear accelerators. A typical generator now available has an accelerating voltage of three million volts and delivers four kilowatts of electron beam-power. This could sterilize samples, of unit density, about an inch thick (irradiating from both sides) at a rate of about a thousand lb. an hour; the cost is estimated at a few pence per lb. of treated product. Thicker samples can be treated by using higher voltage; but this must not exceed approximately ten million volts (sample thickness of about three inches) if induced radioactivity in the food is to be avoided. The British-designed linear accelerator seems to offer most promise of reliable working and also of obtaining high voltages without undue increase in capital cost; models giving several kilowatts of beam power seem feasible, although present models have only a relatively low power-output (500–800 W. at 4 million volts).

The limited penetration of electrons is an obvious disadvantage for many applications, and the much more penetrating γ -rays would often be preferred even though thick shielding would be needed to protect factory personnel from the radiation. Two main sources can be considered: the spent reactor fuel rods in their initial 'cooling' period; and the residues (fission products) which remain after chemical processing of the fuel rods. A medium-sized nuclear power station could probably deliver a million rads to a thousand tons of food a day from the former source; little special provision would be needed except a device for presenting the food to the radiation, provided that the food could be brought to, or near to, the power station. Fission products, on the other hand, could be processed into transportable sources for use in more distant factories, assuming that methods could be developed for moving, safely, the megacurie sources required. It is still too early to estimate, reliably, the probable cost of fission-product radiation, although costs comparable with those for existing electron generators seem possible. The technique of preparing sources has yet to be developed, however, and the potential demand is unknown. It would therefore be preferable at this stage to adopt the alternative approach, as in the United States, of asking industry to indicate what would be regarded as acceptable processing costs. Dr. Wild concluded by saying that further details are available in several publications and that either

PRESERVATION OF FOODS WITH IONIZING RADIATIONS

POWERFUL sources of ionizing radiations have become increasingly available during the past ten years, and a corresponding interest has developed in their use for industrial purposes. Among the possibilities which have received some attention is the utilization of the lethal effects of these radiations for killing micro-organisms in food, thus reducing or eliminating the primary cause of most types of spoilage. If this could be effected without materially damaging the food, and at economical cost, the process could represent a marked advance over

he or his colleagues at Harwell would be glad to discuss them with anyone interested.

Dr. L. H. Gray then outlined present views of the biological effects of irradiation. The primary process is a physical act of energy absorption which leads to the excitation and ionization of individual atoms. The biological damage which results, however, takes several forms, among the most important of which is a loss of the property of cell reproduction; this is eventually followed by cell death or in some circumstances by differentiation. Other less-damaged cells show a partial recovery from the effects of irradiation; but these are generally overgrown by normal or only slightly injured cells. A small proportion of the cells which survive will also usually be found to have undergone a mutation. Tissue cells show a type of response which should particularly be noted, for they give rise to tumours. This carcinogenic effect of irradiation, which is little understood, deserves very serious consideration in connexion with the sterilization of foodstuffs. In studying the cause of these effects it has been found that direct tests of metabolic activity such as respiration, glycolysis and adenosine triphosphate synthesis show little change even with quite high doses. Many important enzyme systems are therefore not damaged; but metabolic steps are undoubtedly involved in the development of radiobiological damage.

The probability of any small unit of biological organization being directly ionized is quite small until the dose reaches levels of the order of millions of r.e.p.; but there is a much greater probability of attack by free radicals arising in the aqueous phase. Various factors such as radiation quality and oxygen tension can be shown to affect indirect chemical reactions of this type in a manner which strikingly parallels their effect on biological response, and it is now believed that much radiobiological damage is due to the action of free radicals arising immediately from water or of more stable radicals to which they give rise.

The last two papers of the symposium were concerned more with the practical aspects of the effects of irradiation on typical food systems. A paper on the effects on micro-organisms by Drs. R. S. Hannan, Marguerite I. Davis and M. Ingram was read in two parts by the first two authors. Dr. Davis first described the general features of the response of micro-organisms. The most important effect is that, with sufficiently large doses of irradiation, the organisms fail to multiply, and this can be accounted for broadly in terms of an ionization having occurred in a sensitive region of the cell. It has recently become apparent, however, that the lethal effect of a given dose can be modified by changes in the environment of the organism, such as removal of oxygen, addition of several types of protective compound, removal of water or change of temperature. These effects are of great practical importance, since they indicate that the dose required to inactivate micro-organisms in a food product will depend to some extent on the nature of that food and the method of processing.

Dr. Hannan then showed how the lethal effects might be utilized. Several workers have shown that even the most resistant spores, in broth suspension, can be inactivated by doses of the order of 2×10^6 r.e.p., that is, equivalent to a temperature rise of 4 deg. C. Yeasts, moulds and vegetative bacteria are somewhat more sensitive. Sterilization without heating is therefore possible and is the most interest-

ing potential application. Much work is still needed with practical food systems; but it seems possible that doses up to 3×10^6 r.e.p. may eventually be found to be necessary, partly to allow for individual circumstances which might protect the micro-organisms and partly to ensure, with a high degree of certainty, that all samples in a given batch will be sterile. Much lower dose-levels might find practical use, however. Approximately 5×10^5 r.e.p., for example, inactivates many of the micro-organisms in most foods and delays the onset of microbial spoilage; harmful vegetative organisms are also destroyed. Even lower doses of $2-5 \times 10^4$ r.e.p. have been used to break the reproduction cycle of insects in foods (for example, *Trichina* larvae or wheat weevil). Very large doses, however, probably of the order of $1-5 \times 10^6$ r.e.p., are needed to inactivate viruses.

Dr. Hannan then went on to describe the effects of irradiation on the foods themselves. The greatest obstacle to the application of the process, apart from economic considerations, is the fact that chemical damage to the food itself can seldom be ignored. Prohibitive changes in colour, odour and flavour frequently occur, and the study of these effects is still largely in the empirical stage. It is clear, however, that the chemical change is limited in total extent (of the order of a few μ moles/gm. for a sterilizing dose) and is of two main types: the indirect effects in the aqueous phase, described by Dr. Gray, and a complex series of effects in the lipids. The most obvious changes appear to be oxidative. Freezing before irradiation, removal of oxygen and adding 'protective' compounds materially decrease many of these effects, and the suppression of damage with most products at high dose-levels usually depends on the feasibility of using auxiliary processes of this type.

Raw beef irradiated with a sterilizing dose of 2×10^6 r.e.p., for example, develops a strong, unpleasant, irradiation odour and flavour; but these can virtually be eliminated by de-aeration and deep-freezing before irradiation. This would be difficult to apply on an industrial scale, however, and an alternative procedure of adding protective compounds, including ascorbic acid, which dispenses with the freezing operation, would be commercially more attractive. Unfortunately, however, this only partially controls the radiation damage, and the chemical basis of the protective action is, moreover, far from clear. In a brief survey of the irradiation of a range of foods, Dr. Hannan pointed out that most products of animal origin develop typical 'irradiation' odours and flavours, and require similar protective techniques. This is especially true with dairy products, where the flavours are usually very strong. Many processed and cured meats show relatively little flavour change, however, presumably owing to the protective effect of nitrite and fat antioxidants which are usually present. The treatment of fruits and vegetables raises many difficulties, if only from the action, during storage, of enzymes which are not usually inactivated by irradiation. The storage life of many other types of product is, in fact, limited by chemical and enzymic change during storage. Even at dose-levels of the order of 5×10^5 r.e.p. which might be used for retarding microbial spoilage, 'irradiation' flavours are usually marked, and it is not until 10^6 r.e.p. or even less that the threshold of sensory detectability is reached with many products. Little change would usually be detectable with doses of the order of 2×10^4 r.e.p.

which might be used for disinfection; but even at this dose-level it is necessary to consider carefully how far irradiated foods can be considered suitable for human consumption. Desirable constituents such as vitamins might be partially destroyed; but the greater possible danger is that harmful compounds might be formed. There has been no positive demonstration that this is a significant danger; but a very great deal of evidence would be required before it could be discounted.

An active discussion followed, most of which was concerned with matters of detail; but one point is noteworthy: the view was expressed that the basis for assessing the potential toxicity of irradiated food need not necessarily be more rigorous than that applied to other methods of processing. It would be illogical to demand the complete characterization of every chemical change irradiation might produce, since this is not even known for kitchen cooking.

No positive conclusion can be drawn from the proceedings of this symposium except that the process is highly novel and of obvious interest. There is, however, no firm indication that it would be commercially applicable in Britain in the near future in any of its many forms. Even if the effects of radiation on foods and micro-organisms were to be clarified, there would still be many problems in assessing the economic value of the process and translating the laboratory results to the factory. The present position is therefore still one of seeking products and methods of processing which offer such unmistakable advantage that the developmental problems can be attacked and overcome. Suitable products may well be found more easily in the pharmaceutical than in the food industry.

R. S. HANNAN

OBITUARIES

Sir Nelson Johnson, K.C.B.

NELSON KING JOHNSON was born on March 11, 1892. He was educated at Canterbury, his native city, and at the Royal College of Science, London, of which he was an associate. After taking his degree he worked for a time on astrophysics under Prof. A. Fowler. In 1913 he went to the observatory at Sidmouth founded by Sir Norman Lockyer for research in solar physics. When war came in 1914 he joined the Royal Flying Corps and became one of the early night-flying pilots. On a night of bad visibility he had a serious crash and this, combined no doubt with the influence of W. J. S. Lockyer, meteorologist as well as solar physicist, led Johnson to the Meteorological Office at the end of the First World War. In 1921 he was put in charge of the new meteorological section of the Chemical Defence Research Establishment, from which so much of our knowledge of the lower layers of the atmosphere has since come.

Johnson himself carried out two investigations of the temperature at different levels by continuous records day and night, for three years at Porton and for five years at Leefield, where he had the assistance of G. S. P. Haywood. No such comprehensive investigation of this problem had previously been undertaken; and no one familiar with the difficulty of eliminating the many sources of error in the continuous measurement, in all conditions of weather, of

atmospheric temperature at levels up to 300 ft., can but admire the way Johnson surmounted the difficulty. A very full analysis and discussion of the records was published in the *Geophysical Memoirs* of the Meteorological Office. Mention may be made of two unexpected results. The rate of increase of temperature upwards at the end of clear calm nights falls off much more rapidly with increasing height than had been expected on the plausible assumption that radiation was the main operating factor; and, most surprisingly, the mean temperature over the twenty-four hours of the day, generally supposed to decrease upwards, was found to increase upwards on the average of the whole year, to a height of 100 ft. Recent records from the tower at Rye, erected at Johnson's instigation, to investigate the vertical distribution of humidity, the fundamental factor in the strange, but vitally important, anomalous radar phenomena, show that there the increase of temperature persists up to 300 ft.

After 1928 Johnson became successively director of experiments at the Chemical Defence Research Establishment at Porton and chief superintendent of the Chemical Defence Research Department of the War Office. During this period the defence arrangements against gas attacks, including the gas masks, admittedly superior to any others in the world at that time, were brought to such a pitch of perfection that they were a major factor in deterring the Nazis from attempting gas attacks against Britain or against her ally, the U.S.S.R., whose civil population had no such effective protection.

In September 1938 Johnson returned to the Meteorological Office as director. His happy combination of scientific comprehension and administrative ability won the admiration of his staff. He devoted all his energy and his time to the task of meeting the demands which the threat of imminent war and, a year later, the outbreak of war, made upon the Office. His foresight enabled him to meet the unprecedented requirements for staff and equipment for Army and Air Force needs not only in the United Kingdom and in the expeditionary forces in Europe and North Africa, but also in the Middle and Far East, in the Colonies, Malta, Iceland, the Azores and partially in Canada and South Africa.

But Johnson was not only an able administrator; he never lost sight of the need for fundamental research. He instituted the Meteorological Research Committee with Prof. S. Chapman as its first chairman; he secured the establishment of the Meteorological Research Flight, the contributions of which to our knowledge of the upper atmosphere, especially of humidity in the stratosphere, have been outstanding; and he formed a section for research in forecasting, working in contact with, but freed from the routine duties of, the operational forecast service.

Meteorology is more dependent than any other science on international co-operation. Johnson took the lead after the Second World War in convening an international meeting in London at the beginning of 1946. He was elected chairman of the International Meteorological Committee and in 1947 president of a general 'Conference of Directors' at Washington, where he achieved an outstanding success. He secured agreement among these directors and their diplomatic advisers, including those of the U.S.S.R. and countries in the Soviet block, on a Convention of Governments establishing an official World Meteorological Organization with the necessary

financial provision and an agreed degree of flexibility in its operation. When the Conference was on the point of breaking down, it was, to quote the words of the Chief of the U.S. Weather Bureau, "the deliberate and skilful guidance of the President" which brought them through all obstacles.

Johnson was made K.C.B. in 1943. We who served under him appreciated and admired his ability, and I am assured that those who served with him and under him in chemical defence research share our feelings and mourn our loss. The strain of the past fifteen years caused or accelerated the development of Parkinson's disease, which defeated our hopes that he would regain his health after his retirement at the end of August last; he died on March 23.

Throughout nine years I saw almost daily evidence of his quiet power and his thoughtful tact. I may mention one illustration. A member of the staff had got into difficulties through his own blunder and deserved censure. When the matter came to Johnson, his first words to me were, "How can we help X out of his difficulties?" He was not only kind; he was strong. When he had decided what was the right course, he could state clearly the decisive reasons for it and reveal reserves of power behind an unassuming manner. The Chief of the U.S. Weather Bureau said the Washington Conference owed him a debt of gratitude; so does his own country.

E. GOLD

Prof. K. Honda

His death occurred on February 12 of Prof. Kotaro Honda in his eighty-fourth year, an almost legendary figure in the field of physical metallurgy and applied physics. Born on February 23, 1870, the second son of Hyozaburo Honda, in the Aichi Prefecture of Honshu, Japan, he graduated in 1897 as a physicist from Tokyo Imperial University. Making his mark while still a research student, he published several papers in collaboration with Prof. H. Nagaoka and alone, on the dimensional effects of magnetization on iron and steel, nickel and cobalt. In 1901 his University appointed him a lecturer in physics and in 1903 conferred the D.Sc. degree on him. During this period his researches were devoted mainly to magnetic subjects such as the dimensional effects observed at high and low temperatures, the effect of stress on magnetization, and the change in the elastic constants of ferromagnetics with magnetization. His wide interests at this time are demonstrated by several papers on geophysical matters. Honda repeated and extended a great deal of the magnetic work done by earlier investigators but exercised greater care and added many refinements, often in very simply conceived apparatus.

Between 1907 and 1911, Honda travelled as a research fellow in Germany, France and England. While in Europe, he worked under Prof. G. Tammann, of the University of Göttingen, in the field of metallurgy and under Prof. du Bois on magnetism. In 1910, he published a famous paper covering the first extensive and systematic investigation made into the magnetic susceptibilities of the elements, about forty in all, but most of the data are now considered unreliable because of impurities. Following his period abroad, Honda was appointed professor of physics at the then newly established Tôhoku Imperial University at Sendai.

A long and prolific period of valuable experimental and theoretical work then followed, on the magnetic

properties of elements and alloys at high and low temperatures; contemporary theories of magnetism; the structure of magnet steels; the solution of equilibrium diagrams by magnetic analysis; the invention of K.S. permanent magnet steel in 1920 (now better known as 35 per cent cobalt magnet steel); the nature of the transformations in pure iron and carbon steels; the theory of the quench-hardening of steels; the study of the formation of cementite; the production of single crystals of iron, cobalt and nickel and their magnetic investigation; the study of martensite; and the development of the new K.S. permanent magnet alloy in 1934. Indeed, his stimulating contributions covered so many branches of the physics of solids and physical metallurgy that it would be invidious to single out any one group for special comment.

Honda's contribution to the establishment of fundamental and applied scientific research in Japan cannot be over-rated; and his influence on, and encouragement of, his students and research associates gave rise to the large output of valuable papers which appeared in the *Tôhoku Science Reports*. He was appointed director of the Research Institute for Iron, Steel and other Metals in 1919, after fostering its foundation. He was also elected a member of the Imperial Academy of Science; the National Research Council of Japan; the board of directors of the Foundation for the Promotion of Science and Industry in Japan; and the Tokyo Institute of Physical and Chemical Research. Finally, he became president of the Tôhoku Imperial University in 1931, which appointment he held until his recent retirement.

A notable stage in Honda's career was reached in 1936, when he attained his twenty-fifth anniversary as professor of physics in the Tôhoku Imperial University. This was marked by the publication of the "Honda Anniversary Volume", a unique compilation including papers from past pupils and colleagues and contributions from leading physicists of international repute.

The Iron and Steel Institute conferred its highest honour, the Bessemer Medal, on him in 1922; this was only one of many awards and honours received by Prof. Kotaro Honda from Great Britain, the United States and Germany, which confirm the great international esteem in which both the man and his work were held.

Prof. Eugeniusz Romer

The death of Prof. E. Romer on January 28 at the ripe age of eighty-four marks the end of an era of cartographical and geographical development in Poland for which he was so largely responsible. His forceful and dynamic personality never failed to make its mark whenever he attended a meeting or conference and will be recalled with pleasure by the many friends he made in Britain at the International Geographical Congress of 1928. The high standard of official maps of Poland and the wide range covered are due especially to his efficient direction. He remained mentally vigorous almost to the day of his death, and in his retirement had turned his attention to some theoretical aspects of geomorphology, notably the development of the river systems of Africa. It is hoped that a summary of this work in English, already planned at the time of his death, may appear posthumously.

L. DUDLEY STAMP

NEWS and VIEWS

Physics at Bangor: Prof. E. A. Owen

PROF. E. A. OWEN retires in September this year from the chair of physics in the University College of North Wales, Bangor, which he has held for the past twenty-eight years. A graduate and 1851 Exhibition Scholar of the University of Wales, Prof. Owen went to the Cavendish Laboratory, Cambridge, in 1910 for postgraduate work under J. J. Thomson, where his work on X-ray absorption led to the discovery of the λ^3 law which is associated with his name. He afterwards joined the staff of the National Physical Laboratory, Teddington, at first holding a post in the Metrology Division, and later became head of the Radiology Section of the Physics Division. There he was largely concerned with the protection of hospital staff in X-ray and radium departments and with X-ray dosage measurements. He served for many years as secretary both to the British and to the International Committee for Radiological Units and took a prominent part in establishing the roentgen as the unit of X-ray dosage and in having it adopted as the international unit. At the National Physical Laboratory, in addition to organizing the routine work, Prof. Owen was active in promoting original research. Under his guidance, with the active co-operation of the late Walter Rosenhain, then superintendent of the Metallurgy Division, and G. D. Preston, now professor of physics in University College, Dundee, work on the crystal structure of metals and alloys was started in 1922 and has continued at the Laboratory ever since. He was also interested at this time in the reflexion of electrons from crystal surfaces, and it is worth while recording that he was only narrowly forestalled in the discovery of electron diffraction. During the tenure of his chair at Bangor, Prof. Owen has built up a reputation for the application of X-ray methods to the elucidation of the structure and properties of metals and alloys. The work of his Department has been characterized by attention to detail and accuracy of X-ray measurements which have done much to throw light on many phase diagrams of binary alloys and related problems.

Dr. E. R. Andrew

DR. E. R. ANDREW, who succeeds Prof. E. A. Owen, has had a distinguished scientific career at Cambridge and Harvard, and latterly at the University of St. Andrews. An open scholar of Christ's College, Cambridge, he took first-class honours in Part 2 of the Natural Sciences Tripos in 1942, and then went to the Radar Research and Development Establishment, where he worked mainly on problems of radar reception and display. He returned to the Royal Society Mond Laboratory in Cambridge after the War to do research on superconductivity and was elected Stokes Student at Pembroke College in 1947. His research was principally concerned with the problem of the intermediate state, that is, the break-up of a superconductor into alternate regions of normal and superconductive material when a rod or plate of the superconductor is subjected to a transverse magnetic field of sufficient strength. His experimental and theoretical work cleared up much that was uncertain in the phenomenon and showed unmistakably the very important part played there by the surface energy of the boundary surface between normal and superconductive regions. Dr. Andrew left the Mond Laboratory to spend a year as

Commonwealth Fellow at Harvard University and was then appointed to a lectureship in natural philosophy in the United College of the University of St. Andrews in 1949. At Harvard he began his work with Prof. Purcell on proton magnetic resonance in solid hydrocarbons and has continued this at St. Andrews, where he has designed and had built a very large permanent magnet which has a highly uniform field, such as is needed for this kind of research. The work which he and his research students have carried out on nuclear magnetic resonance in molecular hydrocarbon crystals has yielded much valuable information. It has been possible to determine unambiguously the positions of the protons in many molecules, to determine the modes of rotation of the hydrocarbon molecules in the lattice, to measure the frequencies of rotation and the height of the potential barriers which hinder rotation and, further, to show, in such crystals as benzene, that the molecules are very free to migrate between lattice sites even at temperatures well below the melting point of the solid.

Agriculture at Nottingham: Prof. F. L. Milthorpe

DR. FREDERICK LEON MILTHORPE, head of the Department of Plant Physiology at the Waite Agricultural Research Institute, University of Adelaide, has been elected to the newly established chair of agricultural botany in the Department of Agricultural Sciences at the School of Agriculture in the University of Nottingham, as from next October. Dr. Milthorpe is an agricultural science graduate of the University of Sydney, and in 1940 became a plant pathologist in the New South Wales Department of Agriculture, a position he held until 1946. During this period his research work concerned the search for rubber substitutes, the growth of fibre flax and of vegetable crops, and diseases of deciduous fruits. During 1946-49 he held a Farrer Scholarship and a Leverhulme Research Fellowship at the Imperial College of Science and Technology, London, investigating the drought resistance of cereals. He has continued research in problems of water relations of plants while holding his present appointment, since 1950, as senior lecturer in charge of plant physiology at the Waite Institute in South Australia.

Geography at University College, Swansea:

Prof. W. G. V. Balchin

DR. W. G. V. BALCHIN, who has been appointed to the newly established chair of geography at University College, Swansea, received his early training in the Cambridge School of Geography. After serving as demonstrator at Cambridge, he worked in the Hydrographic Department of the Admiralty during the War and was appointed lecturer in geography at King's College, London, in 1945. He has worked in the fields of geomorphology and climatology, making notable additions to our knowledge of coastal processes, of the erosion surfaces of south-west England and to the study of local climates. In 1952 he organized an expedition to Arizona in association with Mr. Norman Pye, of the University of Manchester, and the first fruits of the work then done are in course of publication. He had earlier visited Spitsbergen with the 1938 University of Cambridge expedition. His contributions to his subject have been recognized this year by the receipt from the Royal Geographical Society of the Gill Memorial Award. As head of the Department at Swansea he is well equipped to establish a school, giving full

attention to the physical and cartographic aspects of the subject and thus providing a valuable complement to the well-known and long-established school of human geography at Aberystwyth.

Geography at Southampton: Miss F. C. Miller

MISS F. C. MILLER, head of the Department of Geography in the University of Southampton, is retiring at the end of the present academic year. Miss Miller has been a lecturer at Southampton since 1921 and head of the Department for many years. She has maintained the status of the Southampton Department, one of the earliest in the country. The Department has contributed to the subject many academic workers now holding responsible positions in several universities in Britain.

Mr. F. J. Monkhouse

MR. F. J. MONKHOUSE, of the University of Liverpool, has been appointed to succeed Miss Miller, with the title of professor. Mr. Monkhouse graduated in 1935 with a first in the Cambridge Geographical Tripos and, after experience as geography master in several grammar schools, joined the Naval Intelligence Division of the Admiralty in 1941. He was one of the team of workers which produced the "Geographical Handbooks" for Service use; his own contributions were chiefly on West European countries. After a short spell in Ceylon with the Inter-Service Topographical Division, he was appointed to the Department of Geography in the University of Liverpool in 1946. While in Liverpool, he has been most active in both teaching and research. In particular, he has developed cartographical teaching to a high level and, in collaboration with Mr. H. R. Wilkinson, also of the Liverpool Department, has written "Maps and Diagrams", which has become a standard text. His book "The Belgian Kempenland" (in the series "Liverpool Studies in Geography") and his papers on the economic geography of the Low Countries indicate his interests in the economic geography of Western Europe, and he has in addition a number of papers on the historical geography of England, including a chapter on Worcestershire in the forthcoming second volume of Prof. Darby's "The Domesday Geography of England".

Element 100

THE announcement in *The Times* of April 12 of the production of element number 100 by Prof. G. T. Seaborg and his collaborators at the University of California follows closely on their discovery of element 99 (see *Nature*, February 13, p. 290, and *Phys. Rev.*, 93, 257 and 908; 1954). Although full details of this work have not yet been published, it is clear that extreme care in the handling of minute quantities of short-lived radioactive products was necessary, and the successful outcome of the experiments is a major technical achievement. The mass number of the isotope of element 100 that has been identified is given as 263, and its half-life is about three hours. It was prepared from a plutonium isotope (presumably plutonium-239) by successive neutron capture, which increases the mass, followed by beta-decay, which increases the atomic number. As a first stage in the process, californium (element 98) was separated chemically from the irradiated plutonium, probably by ion exchange and precipitation methods; the californium in turn was bombarded by neutrons, and elements 99 and 100 so

obtained. Since it appears that at least fourteen neutrons must have been added to the original material to arrive at the mass number quoted, it is obvious that the work demanded very intense neutron fluxes, such as are available in the reactors of the U.S. Atomic Energy Commission. Identification of the new isotope was presumably based on the α -decay systematics, built up by Prof. Seaborg and others, which have proved extremely reliable in this field. Element 100 is stated to behave chemically like erbium, its analogue in the rare-earth group. There is no reason for believing that this will be the last new element to be prepared, although the increasing probability of spontaneous fission as the atomic number advances would appear to limit the total number of elements to about 110.

Colonial Relations in the British Commonwealth

REPLYING for the Government in a debate in the House of Commons on April 2, initiated by Mr. C. J. M. Alport on a resolution calling for re-examination of the spheres of responsibility of the Colonial and Commonwealth Relations Offices and reorganization of the services for which they are responsible, the Minister of State for Colonial Affairs, Mr. H. Hopkinson, rejected the suggestions made in the debate for appointing a Secretary of State for Africa, merging the Colonial Office and Commonwealth Relations Office, or transferring the economic functions of the Colonial Office to the latter Office. In the Government's view the time has not yet come for any major definition of the spheres of responsibility between the Commonwealth Relations Office and the Colonial Office. Nevertheless, it might be desirable to examine the relations between the respective services and the need for the reorganization of the Colonial Office as a whole. In the view of the Government, re-examination of the conditions of service of members of the Colonial Service is urgently needed, for it is of the greatest importance that Colonial officers should be assured that their problems and anxieties are understood and treated seriously.

Mr. Hopkinson did not think that the proposal for a joint Commonwealth service would help this particular problem, but he would not exclude schemes in which Colonial servants, as part of some new overseas service, could be made available when required by independent Commonwealth countries or indeed by foreign countries. The Government recognizes that it has a special responsibility towards officers of the Colonial Service who, appointed to their present posts by the Secretary of State, are in those areas developing towards full self-government which are anxious to ensure that officials retained by them should owe principal allegiance and loyalty to them. Up to now, Colonial Governments have not behaved irresponsibly or unfairly towards their British Civil servants, but the Government feels that, as long as these officers remain, they should be assured of certain basic conditions of service, including pensions and other benefits, retention of their status in H.M. Colonial Service, and possibilities of transfer and promotion, and so on. At the same time, they should be permitted to retire from the service of the Colonial country by which they are employed when it attains independence. The Government, said Mr. Hopkinson, believes that there is still a great work for these officers and wishes them to know that the House and Government are aware of their needs and are determined to give them every practical assistance for carrying on their great task.

Age of Election to the Royal Society

IN a recent note, Prof. A. V. Hill has discussed the age of election to the Royal Society of London (*Not. and Rec. Roy. Soc., Lond.*, 11, No. 1; January 1954). For many years, up to and including 1930, the number of annual elections to fellowship of the Royal Society (apart from 'special' elections under Statute 12) was fifteen. During 1931-38 it was seventeen, during 1939-45 it was twenty, and since 1946 it has been twenty-five. The 'median' age of election (that is, the age above which as many elections occur as below it) has been shown as: 1848-72, 42; 1873-97, 43; 1897-1922, 44½; 1920-38, 47; 1939-45, 49½; 1946-53, 47½. These figures include elections in all scientific categories. In eight different categories the median ages have been:

	1920-38	1939-53
Mathematics	43	42
Physics	39	44
Chemistry	45	45
Engineering	55	54
Geology	53	51
Botany	51	52
Zoology	48	50
Physiology	48	49

This confirms the general conclusion that there has been little change over the past thirty-four years, though this is probably due mainly to the fact that the number of annual elections has increased in the ratio of 5:3. The median age of election differs greatly between the categories; and this difference is the more striking when it is recalled that practically no elections take place under thirty-two, so that, for example, half the elections occur in ten years in mathematics and in twenty-two years in engineering. One reason for this difference is that in some subjects experience is far more important than in others, where natural ability is the chief element in success. Prof. Hill writes that the number of scientific people qualified for election is rising rapidly and that, if seventeen elections annually were appropriate in 1931, twenty-five will be too few before long. The number of annual elections should be adjusted from time to time so that the median age of election could be kept around forty-five.

Impact of Science on Society

RECENT copies of the quarterly magazine, *Impact*, have contained articles of considerable interest to those interested in the social aspects of science. In the latest issue, Dr. A. King states that international collaboration in scientific research and development can be extremely valuable only if the projects are appropriate for international effort and present real advantages over normal national or institutional means. International scientific co-operation should be based on real needs rather than on idealistic or political principles (4, No. 4; Winter 1953). An earlier issue of the journal contains an article by Dr. C. Sarnie on the scientific detection of crime; he shows that the introduction of scientific methods in the detection of crime is of great social value because it makes for greater certainty in the administration of justice (4, No. 3; Autumn 1953). In the Summer 1953 issue (4, No. 2), R. T. Eddison has contributed a valuable article on the social application of operational research, and Dr. Armando Cortesao, the distinguished Portuguese historian of science, has shown how the application of nautical science made possible the great geographical revolution at the end of the fifteenth century. *Impact* is available at H.M.S.O., price 2s. 6d. for each issue.

Imperial College of Science and Technology, London

AN account of research activities carried out at the Royal College of Science during the three years, 1950, 1951 and 1952, has recently been published. The publication is a brief general review and is written in non-specialized terms similar to the booklet issued by the City and Guilds College last year to describe its research in engineering. Contributions are included from eight departments of the College, including botany, inorganic and physical chemistry, organic chemistry, geology, mathematics, meteorology, physics and zoology and applied entomology. The greatest range of investigation has been carried out in the Department of Inorganic and Physical Chemistry and varies from analyses of the structure of solids to the physical chemistry of ion-exchange resins as well as problems of crop nutrition and insecticide chemistry. In the Department of Geology, studies have been carried out on the Caledonian Mountains of Britain, while, in the Department of Mathematics, theoretical cosmology has been one of the fields of investigation. The report is admirably written and discreetly illustrated. It is hoped that, next year, the Royal School of Mines will publish a similar booklet, so completing a trilogy of publications of this sort for the three colleges which make up the Imperial College of Science and Technology.

Rugby School Natural History Society

THE Report of the Rugby School Natural History Society for 1953 is the eighty-seventh in the series and reveals that the Society is in a flourishing state and is keeping up a long and splendid record of work. The museum has been redecorated and extended, and the vivarium improved mainly by clearing, cleaning and restocking the pond. During the year, four lectures were given by visiting specialists. The ecology of a pond has been the subject of study for about thirteen years. An account of the period 1940-46 was published in the Report for 1946, and in the present Report the account, with illustrations, has been brought up to date. A bird census for 1953 is given. T. Fawcett describes work on an excavation at Brownover, where pieces of interesting medieval pottery were unearthed; so also were two St. Neots ware sherds dating from late Saxon time and believed to be the first found in Warwickshire. Reports of the library, museum and vivarium and of the Society's field sections—zoological and entomological, ornithological, geological, archaeological—are here published. (It is curious that the Society seems to have no botanical field section, though judging from the report of the zoological and entomological section, its members also admit botany.) Affiliated sections also report their year's activity; they comprise architectural, meteorological, photographic, astronomical, chemical and physical, railway, wireless and aero-modelling. Numerous prizes covering many aspects of science are being offered. Rugby School is to be congratulated on the excellent work being done by its Natural History Society and affiliated sections.

Science Service of the Canadian Department of Agriculture: Annual Report for 1952-53

THE annual report of the Director of Science Service of the Department of Agriculture, Canada, for the year ended March 31, 1953 (pp. 56 + 4 plates. Ottawa: Queen's Printer, 1953), which is reprinted from the report of the Minister of Agriculture,

endeavours to give a representative picture of the work going on in the Ministry's various laboratories across Canada, more particularly the work directly related to important problems in agriculture and forestry. The extent and variety of this work is shown in a list of 284 research papers published during the year, which is appended to the report. In animal science, investigations were concerned with the basic aspects of nutritional and physiological problems and the protection of livestock and man from animal pests. Experiments in Alberta with spraying and dusting machines, for example, showed that spraying sheep with DDT in the spring was effective against tick, being more rapid than dusting and easier on the animals. Loss of repellency of dimethyl phthalate to mosquitoes was found to be due largely to absorption through the skin, while a rotary-brush spraying device attached to aircraft, which has been developed by the Entomology Division, proved the most effective and economical spraying device so far tested. In plant science, emphasis is placed on researches relating to hazards confronting farmers and foresters from plant diseases and insect pests, and the bulk of the report records the many useful results obtained in such investigations. A further section of the report describes the work in soil science, including microbiology, soil chemistry, taxonomy and antibiotics, while professional services, both organized and informal, which were rendered to different groups within the Department of Agriculture, to other Dominion Departments and to the public, constitute an important feature of the activities of the Department.

Carotid Rete and Its Associated Arteries

A PAPER entitled "Studies of the Carotid Rete and its Associated Arteries", by P. M. Daniel, J. D. K. Dawes and Marjorie M. L. Frichard (*Phil. Trans. Roy. Soc., B*, 237, pp. 173-208 + pls. 12-19; July 1953; 8s.), records an investigation into the cranial arteries in a series of mammals more particularly with respect to the well-known rete mirabile cerebrale, here termed the carotid rete. The animals employed were cat, sheep, ox, goat, pig, dog, rabbit and rat. The rete was found to be well developed in the first five, in a very much reduced form in the dog, but not at all in rabbit or rat. The techniques employed were the use of radio-opaque injection masses from which stereoscopic radiographs were taken, and of injection with neoprene latex. After the setting of the latter, the vessels were dissected *in situ* or the tissues were completely macerated, leaving only the casts of the blood-vessels. This enabled the position of the main vessels in relation to one another and to the bony tissue, the relation of the vessels to the soft tissue and finally the detailed structure of the rete and its associated vessels, to be readily ascertained. How successful the neoprene latex injections were is clearly shown in the nineteen excellent photographs on the eight plates. The rete is found to be intimately associated with the major arteries supplying the brain, and its presence is associated with a reduction or absence of the internal carotid artery. This is still true of the cat where, in contradistinction to the artiodactyles, the rete is extracranial, lying in a venous lake surrounding the internal maxillary artery immediately below the base of the skull. In the other forms the rete lies intracranially in the cavernous sinus. The rete itself consists of a network of medium-sized arteries about 250 μ in diameter, which interlace and anastomose in a complicated

manner. It would appear from its size, its complexity, its relation to the cranial blood supply and its close association with venous blood, that it must serve some functional need; but what this need is or how it is served remain unsolved problems.

The Oriental Earthworm

THE value of earthworms in increasing fertility of the soil is well known. There are situations, however, in which the good done by earthworms is outweighed by the damage and inconvenience that they cause. In recent years a new species, the Oriental earthworm, *Pheretima hupoiensis*, has appeared in Connecticut and other eastern states of U.S.A. It has proved to be a much more serious pest than the native species and is more or less immune to treatments used to kill native earthworms. J. O. Schread has described the habits of the new earthworm and experiments on its control in specialized turf areas (Bull. 556; April 1952; Connecticut Agricultural Experiment Station, New Haven). The worm is apparently very prolific and the production of hundreds of casts following heavy rainfall has seriously damaged golf greens; hundreds of pounds of castings have been left on each heavily infested green every year. Control measures used for native earthworms were not effective in controlling the Oriental earthworm. Parathion applied four times, totalling about a hundred pounds per acre, reduced the population about 97 per cent; some injury was caused by the final application. Chlordane emulsions were more effective than wettable powders. Single treatments using 40 pounds of chlordane per acre had a highly killing effect and prevented reinfestation for long periods of time. Aldrin in the form of either wettable powders or emulsion at the rate of 33 pounds per acre first activated the worms, but provided good control after several weeks. Other chemical reagents also produced good results.

Enzymes of *Aspergillus oryzae*

THE sequence of appearance of the enzymes liberated by *A. oryzae* during its growth and some of the properties of these enzymes have been described and discussed in a series of studies by W. G. Crewther and F. G. Lennox (*Austral. J. Biol. Sci.*, 6, 410, 428, 447; 1953). When a strain of the mould *Aspergillus oryzae* is grown in surface culture on a protein-free sucrose-tartrate medium, enzymes are released into the culture medium in the following order: first, the carbohydrases sucrose and amylase together with phosphatase; second, the proteases and esterases; and third, catalase. Their liberation is accompanied by the appearance of protein nitrogen in the medium and loss in weight of the mycelium. Evidence is presented for the presence of at least two proteases in addition to glycyglycine dipeptidase—one reduces the viscosity of gelatin very rapidly and is believed to act preferentially on the high-molecular-weight fractions of gelatin (the 'viscometric protease'), whereas the other degrades the lower molecular components of the gelatin more readily (the 'gravimetric protease'). The pH activity curves for sucrose and amylase also indicate the presence of more than one component. Inactivation of the various enzymes present during incubation at 40° C. and at different pH values has been followed. These papers also give a full account of the fractionation and preparation of crystals rich in protease and of the ethanol fractionation of enzymes at low ionic strengths.

Macromolecular Chemistry: Symposium In Italy

A SYMPOSIUM on macromolecular chemistry will be held in Milan and Turin during September 27–October 3 under the auspices of the Commission of Macromolecular Chemistry of the International Union of Pure and Applied Chemistry. Four subjects will be discussed at the symposium: characterization of polymers in relation to their technical properties (molecular weight and molecular-weight distribution, branching and cross-linking, and crystallization); building reactions of macromolecules; transformation reactions of macromolecules; and block polymers and graft polymers (preparation and properties). Papers will be considered for the symposium, written in French, English, Italian and German, and must be submitted before April 30; those covering the first subject should be sent to Prof. Antonio Nisini, Istituto Chimico, Università, Corso Massimo d'Azeglio 48, Torino, and those for the other three subjects to Prof. Giulio Natta, Istituto Chimico Ind. Politecnico, Piazzale Leonardo da Vinci 32, Milano, who together will be the editors of the publication of preprints and proceedings. The papers and discussions will be published in a special issue of *Ricerca Scientifica* which will appear shortly after the end of the meeting. People in Britain wishing to attend should write in the first place to the British National Committee for Chemistry, Royal Society, Burlington House, London, W.1.

Council for the Promotion of Field Studies

THE Council for the Promotion of Field Studies organizes a very large number of courses throughout the year which should appeal to many persons, both amateur and professional, with outdoor interests or hobbies. The courses are generally based on one of the Council's four field centres: Flatford Mill, East Bergholt, near Colchester, Essex; Juniper Hall, Dorking, Surrey; Malham Tarn, near Settle, Yorkshire; and Dale Fort, Haverfordwest, Pembrokeshire, with which is also associated the Skokholm Bird Observatory. The Council is particularly well known to naturalists of all descriptions, with specialized interests in the whole field of the plant and animal kingdoms; but the term 'field studies' goes well beyond the biological world, and those interested in, say, oceanography, geology, archaeology, geography, mapping and surveying, and meteorology will find their tastes catered for. Again, the standards are varied and range from the quite elementary to the advanced; courses tending towards the latter category are often run in conjunction with some other organization, prominent among which is the University of London. The field centres take about fifty persons at a time (many of whom can be accommodated in single rooms or cubicles), and there are well-equipped laboratories and basic outdoor equipment at each to keep the students fully occupied. The normal period of residence is one week, and the charge, which includes full use of the centre as well as board and lodging, is £5 15s. 6d. a week (Skokholm £4 14s. 6d.). Further information about each field centre and its courses can be obtained from the wardens at the above addresses, or from the Publicity Officer of the Council at Ravensmead, Keaton, Kent.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: T. Y. Watson

(director of agriculture, Uganda), secretary for agriculture and natural resources, Uganda; J. A. Burra (assistant conservator of forests, Windward Islands), assistant conservator of forests, Cyprus; A. M. J. De Swardt (senior geologist, Geological Survey Department, Nigeria), principal geologist, Geological Survey Department, Nigeria; P. B. N. Jackson (scientific officer, Northern Rhodesia), senior scientific officer, Northern Rhodesia; K. H. Bain (fisheries officer, Gold Coast), fisheries officer, Federation of Malaya; O. P. Wood (senior agricultural survey officer, Gold Coast), principal agricultural survey officer, Gold Coast; G. Stell, entomologist, Trinidad; A. R. Rees, awarded a Colonial research studentship with the view of appointment as a scientific officer (plant physiologist); F. J. Parker, veterinary officer, Uganda; R. J. Campbell, veterinary officer, Gold Coast; D. Clay, veterinary officer, Department of Agriculture, Jamaica; P. J. French, veterinary officer, Kenya; A. R. Mahood, entomologist, Veterinary Department, Nigeria; E. O. Trump, field zoologist, Veterinary Department, Kenya; J. L. Williams, statistician, East Africa High Commission.

Announcements

PROF. A. KASTLER, of the Faculty of Sciences, University of Paris, has been awarded the Holweck Medal and Prize for 1954 and will deliver the ninth Holweck Lecture in the rooms of the Royal Astronomical Society, Burlington House, London, W.1, on May 13, his subject being 'Les Méthodes Optiques d'Orientation Atomique et leurs Applications'. The Holweck Medal was founded by the Physical Society as a memorial to Fernand Holweck and to other French physicists who suffered or met their deaths during the occupation of France during 1940–44 and is presented in alternate years to a French physicist and to a British physicist, the recipient being a physicist distinguished for his work in experimental physics.

DR. J. R. NICHOLLS is retiring from the post of deputy government chemist on April 30 after forty-three years in the Department of the Government Chemist. His services are being retained in another capacity. His successor will be Mr. E. H. Nurse.

A WESTERN SECTION of the Society for Analytical Chemistry has recently been formed following an application signed by many members resident in the West of England, and the inaugural meeting will be held at noon on May 8 in the Lecture Theatre of the Technical College, Newport, Monmouthshire. After a business session in the afternoon, Dr. D. W. Kent-Jones, president of the Society, will address the Section on "Alcohol Determination and its Medicolegal Aspects".

THREE special summer courses will be held in the Massachusetts Institute of Technology as follows: June 15–25, developments in machine-tool technology (under Prof. M. C. Shaw, of the Machine Tool and Metal Cutting Division, Department of Mechanical Engineering); June 16–29, operations research as applied to solving industrial, business and government problems (under Prof. P. M. Morse, professor of physics); and August 23–September 3, automatic control of machine tools (under Prof. J. F. Reintjes, director of the Servomechanisms Laboratory). Application forms and further information on these courses can be obtained from the Summer Session Office, Room 7-103, M.I.T., Cambridge 39, Mass.

RADIO-METEOROLOGY

CONFERENCE IN TEXAS

A CONFERENCE on radio-meteorology was held in Austin at the University of Texas during November 9-12 last, sponsored by the American Meteorological Society, the Institute of Radio Engineers, the Radar Weather Conference, and the American national groups of Commission II of the International Scientific Radio Union and of the Joint Commission on Radio-Meteorology of the International Council of Scientific Unions. Some two hundred participants, widely representative of university, government and industrial scientific laboratories, attended the meetings.

The subject of radio-meteorology, which embraces several aspects both of the influence of meteorological factors on radio-wave propagation and of the use of radio techniques for studying features of the weather, has expanded greatly and increased in importance during the past few years. Work is still in progress in different parts of the world which is directed to the explanation of phenomena of which something was known twenty or more years ago; in addition, new fields of investigation, largely stimulated by wartime experiences in the operation of centimetre-wave radar, are being intensively pursued.

Tropospheric Wave Propagation

The conference was organized into eleven sessions, and the first four of these were concerned with the effects of the troposphere on the propagation of very short radio waves. The first paper, by T. J. Carroll, presented a review of existing knowledge of tropospheric propagation to points well beyond the horizon. Experiments during recent years have shown that, at such ranges of transmission, radio field strengths at very high frequencies are much greater and more reliable than have been predicted from standard theory. Of the explanations advanced to account for this phenomenon, there was considerable discussion of two, namely: that the fields are due to scattering of incident radiation caused by turbulent fluctuations of the refractive index of the atmosphere; and that the partial internal reflexion arising from the normal negative gradient of refractive index in the atmosphere is in itself sufficient to give fields of the order of magnitude of those observed. But it would appear that the explanation in terms of scattering by turbulent eddies finds the greatest support. Although it is felt that the scattering theory needs some refinement, it is not generally considered that the partial internal reflexion hypothesis has anything to offer towards such refinement; some account must ultimately be taken of the fact that the scattering centres are not spherical, which has so far been assumed to be the case.

Scattering of radio waves from a turbulent elevated layer formed the subject of a paper by W. E. Gordon, who said that airborne radio-refractometer observations in the United States indicate that such layers occur frequently. Within the layer the scale of turbulence is observed to be somewhat larger, and the intensity many times greater, than the values of these quantities observed above or below the layer. The scattered power from the layer received at certain distances may easily equal or exceed that from an atmosphere without such a layer.

Centimetre-wave refractometers are being exploited on an increasing scale in the study of the detailed refractive-index structure of the atmosphere, and these instruments have now been carried by aircraft to altitudes of 25,000 ft. Investigations of this nature were described by C. M. Crain and J. R. Gerhardt, by L. W. Cowan and by P. B. Taylor. The development of this form of refractometer as a new and sensitive instrument for the exploration of the refracting properties of the atmosphere of interest both to the meteorologist and the radio engineer, represents one of the most important steps of recent years in this field of study. Measurements of atmospheric refractive index have already been made over many coastal and interior regions of the United States for a wide range of climatic conditions. Airborne soundings have shown the existence of intense discontinuity layers which are not nearly well enough delineated by ordinary radio-sonde ascents. Examinations of turbulent structure show scales up to hundreds of metres with fluctuations of refractive index in the free air of the order of 10^{-4} (1 *M*-unit)—except in extremely turbulent layers where greater fluctuations are found—and decreasing as the altitude increases.

Considerable interest was shown at the conference in the properties of elevated layers in which the lapse-rate of refractive index with height is significantly greater than that appropriate to the standard atmosphere. Such layers, which usually occur at various heights below about 10,000 ft., play an important part in the determination of very-short-wave propagation characteristics. B. M. Fannin described the application of ray-tracing techniques to the evaluation of radio field-strengths in the presence of these layers, and P. B. Taylor discussed the effect of the layers on air-to-air propagation at very high frequencies in producing what has become known as the 'radio hole'. As two aircraft fly apart at a constant height above one of these abnormally refracting layers, it is frequently observed that there is a deep fade in the radio signal during communication between the aircraft. This 'radio hole' begins at a range of 50-200 miles, depending upon the heights of the aircraft and the layer, and continues out for a further 50-100 miles; beyond this the signal reappears in strength and rises, with intermittent fades, to levels well above the free-space value. Often a useful signal continues far beyond the normal radio-horizon. Some theoretical aspects of reflexion at elevated layers in very-high-frequency transmission between ground stations were outlined by F. H. Northover.

During the sessions on tropospheric wave propagation, a group of papers was presented by members of the staff of the Central Radio Propagation Laboratory of the National Bureau of Standards. Reviewing the programme of propagation research at the Bureau in the frequency band 100-1,000 Mc./s., J. W. Herbstreit said that the programme has included studies of terrain and meteorological effects on transmission loss within and beyond the line of sight. An important series of measurements is that being carried out with transmitters located at the Cheyenne Mountain Field Station, Colorado Springs, and with receiving points situated at various dis-

tances over the plains of Colorado, Kansas and Arkansas. B. R. Bean described the prolonged space-wave fade-outs within the radio-horizon which have been found to occur in these experiments at a frequency of 1,046 Mc./s. The occurrence of these fade-outs coincides with widespread nocturnal super-refraction, as evidenced by enhanced signals beyond the line-of-sight and ground modification of the refractive index profile. A paper on the meteorological instrumentation at the Mountain Field Station was presented by M. C. Thompson and K. O. Hornberg.

Climatic maps of the monthly average refractivity gradient have been drawn up for the United States for the hours of 03.00 and 15.00 G.C.T. These maps follow a regular climatic pattern, and the refractivity gradients have been correlated with the monthly median transmission loss of all available very-high-frequency propagation paths. The usefulness of this approach for the prediction of very-high-frequency transmission loss was discussed in a paper by B. R. Bean and Frances M. Meaney. Theoretical work at the National Bureau of Standards has sought to explain the observed propagation characteristics in terms of a modification of smooth-earth diffraction theory to include the effects of irregular terrain, climatic conditions, knife-edge diffraction and scattering in the turbulent atmosphere. It might perhaps be pointed out that much of the work of the Bureau in this field is designed to be of assistance to the Federal Communications Commission in the task of frequency allocation for various very-high-frequency and ultra-high-frequency services.

Other papers on tropospheric wave propagation were concerned with the prediction of diurnal field-strength variations at a frequency of 100 Mc./s. from synoptic data (by F. R. Bellaire and W. A. Arvola), a procedure which, although not yet fully explored, appears likely to prove fruitful; while L. J. Anderson and E. E. Gossard described attempts to deduce refractive index profiles within a surface duct over the sea from meteorological measurements at two heights only, and also the associated trapping of centimetre waves. The forecasting of propagation conditions from a knowledge of the synoptic situation also formed the subject of a paper by A. D. Hood and L. H. Doherty, in this case the aim being to predict the performance of a radar operating over Lake Ontario at a wave-length of 3 cm.

An account was given by C. W. Tolbert and A. W. Stratton of experimental observations on the transmission of 8-mm. waves over optical paths of various lengths up to fifty miles in which highly directive aerials were used. The signal-level was generally found to be in agreement with the free-space value corrected for absorption due to water vapour and oxygen in the atmosphere, although there were, as expected, fluctuations produced by atmospheric inhomogeneities over the path. Steady signals with small loss due to water droplets were experienced in fog, but severe attenuation was caused by showers of rain.

Thunderstorm and Tornado Atmospherics

The fifth session of the conference was devoted to the consideration of thunderstorm and tornado atmospherics, and the general problem of thunderstorm location from the observable characteristics of atmospherics. H. L. Jones described a programme of research which has as an objective the identification and tracking of tornadoes from observations of the

peculiar and abundant electrical discharges accompanying severe storms. It has been found that a line-squall, even though it appears as an extended echo on a radar screen, is composed of a number of separate storm centres each acting as a generator of atmospherics; further, as the intensity of an individual storm centre increases, the rate of arrival of atmospherics at a given receiving station increases. By observing the rate of arrival of atmospherics, and also the distribution of high- and low-frequency components, it is possible to classify storms according to their severity. The more severe storms and tornadoes are characterized by an arrival rate of 10 strokes/sec. or more, and a predominance of high-frequency components.

The recording and classification of thunderstorm atmospherics by counter techniques was discussed by M. M. Newman, J. R. Stehmann and J. R. Anderson, while E. R. Pierce and T. W. Wormell, in a communicated paper, described work at the University of Cambridge which shows that regular night-time atmospherics consist either of a series of peaked pulses fitting the concept of successive ionospheric reflexions or of a smooth quasi-sinusoidal oscillation that does not obey the simple reflexion picture. Regions producing quasi-sinusoidal wave-forms do not generate peaked atmospherics and vice versa, and all quasi-sinusoidal wave-forms observed at Cambridge originate from the south-west at distances exceeding 1,600 km. It was pointed out that observations near the eastern coast or the centre of the United States would assist in establishing the cause of these curious geographical effects.

The characteristics of the lightning discharge channel are important factors in the determination of the nature of atmospherics. The channel resistivity, its surge impedance, and the propagation velocity of the discharge all involve non-linear variations which lead to interesting stepped currents. It was shown by M. M. Newman how equivalent electrical circuits could be derived and used for the calculation of the currents in discharges; the currents so obtained are in good agreement with experimental observations.

What are believed to be the first P.P.I. photographs (pictures recorded on a cathode ray tube) that include information on atmospherics were presented by D. M. Swingle. This technique permits the detailed location of electrical activity among the radar storm echoes.

Cloud and Precipitation Physics

Cloud and precipitation physics were discussed in Sessions 6-9 of the conference. In a review of this field of study, S. E. Reynolds directed attention to the fact that observations have shown that it is unnecessary to invoke the Bergeron ice-crystal mechanism to account for certain types of precipitation occurring over much of the earth's surface. The development of precipitation particles without the intermediate stage of ice is well confirmed in tropical regions as well as in the middle latitudes for both coastal and inland areas.

The general characteristics of radar echoes obtained from various forms of precipitation were surveyed by Pauline M. Austin. A spherical rain-drop scatters radiation which is polarized in the same direction as the incident wave. For a non-spherical particle, however, some of the scattered radiation is cross-polarized, the proportion being dependent upon the shape, orientation and composition (ice, water or

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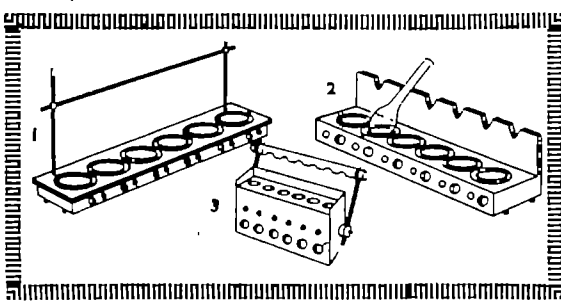
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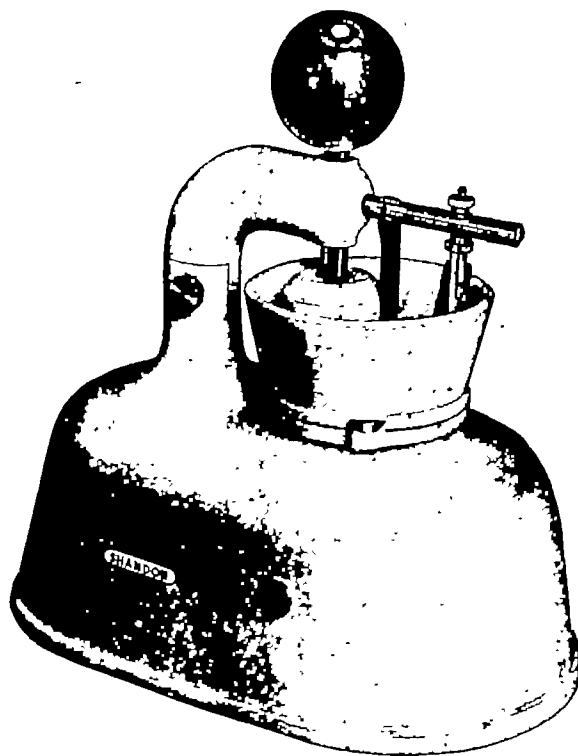
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mixture) of the scatterer. Measurements made with different polarizations, or observation of the cross-polarized component, should therefore give valuable information concerning these quantities. Such measurements are especially desirable in the case of bright-band echoes, where the values of the average echo intensity are difficult to interpret. It was suggested that future research in this field may well follow two rather different lines. The first is technical in nature, and includes improvement in the extent and accuracy of the measurements, overcoming problems such as saturation of the receiver and extraneous fluctuations, and the development of the instrumentation for the quick and easy observation of such quantities as precipitation-rate and turbulence. The second type of research is related to the interpretation of the experimental data. There are, for example, many occasions where the presence of the bright band at a relatively low altitude prevents the estimation of rainfall from echo intensity except at very short ranges. This indicates the need for an empirical relation which involves not only the echo intensity and the rate of precipitation of rain, but also other pertinent quantities such as the height of the bright band, the range, and the beam-width of the antenna. A more complete analysis of the physical processes occurring within the bright band is also needed.

There is in progress in the United States and Canada a considerable amount of work on cloud and precipitation physics, and on the deduction from the nature of precipitation echoes of such factors as rainfall intensity, the growth and melting of snowflakes, and wind shear and turbulence. Other contributions to these topics at the conference were made by D. S. Johnson, with particular reference to rain from warm clouds in Hawaii; by P. M. Austin and R. Wexler on the subject of radar echo intensity at different levels in steady snow; and by K. L. S. Gunn, who presented radar evidence of a generating level for snow. In the last-named work a study of vertical radar records and upper-air data for twenty-two days of snow at Montreal has revealed that well-defined snow-trail patterns occur (on a height-range radar display) on days when the air aloft is stable. In these situations snow develops in discrete generating elements, of considerable lifetime, which exist in a layer of middle cloud. The top of this cloud is less than 200 ft. above a frontal surface on these stable days. At times when the warm air is unstable, the trail patterns are not so well defined, and the top of the cloud is farther from the frontal surface.

Further papers in the cloud physics section were those on the lowering of the bright band during heavy rain (R. Wexler and J. Honig), optical transmission through rain (D. Atlas), the deformation of large raindrops (J. E. McDonald), and the reliability of radar measurements of rainfall (F. A. Huff and J. C. Neill). D. Atlas also described some quantitative measurements at a wave-length of 1.25 cm. on the echo intensities of fog and rain. The echoes from light rain agree well with those calculated from the existing theory; but the measured intensities with heavy rain are a few decibels lower than the theory would indicate. An account was given by R. K. Moore of measurements made aloft of the distribution of drop sizes in thunderstorms by means of a shadowgraph technique.

J. S. Marshall discussed the manner in which the size distributions of raindrops may vary during the process of precipitation. In calculations relating to

this, it is assumed that the distributions as they originate in cumulo nimbus cloud, or at the melting-level, are like those observed at ground-level, but more consistent. Subsequent developments, when the drops are falling, by raindrop coalescence, cloud accretion and evaporation modify the distributions only to a small extent, so that any changes could scarcely be distinguished within the experimental accuracy of most observations. In the case of showers, wind shear can lead to a separation of the drops according to size: the resultant error in the measurement of rate of rainfall by radar, however, should diminish greatly when an average is taken either over a period of a few minutes or over an area of a few square miles.

Observations of rain echoes using a continuous-wave radar system operating at a wave-length of 8 mm. were described by D. G. Kiely, who also commented on some peculiar super-refraction effects noticed in transmissions at the same wave-length over a one-mile sea-path. In the rain-echo experiments a comparison was made between a radar system operating with a single aerial and one with dual aerials. The results show that the intensity of echoes is much less with a dual than with a single aerial system, but that there is a well-defined distance of separation between the aerials of a dual system beyond which greater spacing leads to little decrease in echo intensity. It also appears that fluctuations of the echo signal are not very dependent upon the rate of rainfall over a fairly wide range.

Operational Uses of Weather Radar

The last two sessions of the conference were devoted to papers on the operational uses of weather radar. The radar storm-detection programme of the United States Weather Bureau was outlined by V. D. Rookney, and from this it appears that although, as M. G. H. Ligda pointed out, little direct progress has been made during recent years on the utilization of radar storm observations for weather-forecasting purposes, more rapid developments in this field may be expected in the near future.

Considerable interest was aroused by papers dealing with the nature of radar echoes obtained when tornadoes are within range of observation, for any assistance in the issuing of warnings which leads to the reduction of damage caused by tornadoes is naturally of great importance in the United States. J. C. Freeman described observations of radar echoes from storms associated with tornado situations in Texas during the spring of 1953: these observations showed that three tornadoes were closely linked with very large and intense cloud-echoes, and in all these cases the large echoes were in a region of observable convergence of the surface winds.

A new theory concerning physical processes in the development of tornadoes was advanced by F. O. Roessmann. According to this theory there is no updraught in the funnel of a tornado, as is generally assumed, but on the contrary there is a strong down-draught, caused by moist labile conditions, which is stabilized by the revolving motion of the air mass in the funnel. It was further suggested that it might be possible to destroy a tornado by causing the explosion of a missile, guided by means of weather radar, at the appropriate point in the tornado, an idea which was supported by R. H. Mayer. The new theory produced much controversy and was clearly unacceptable to many members of the conference.

D. M. Swingle and L. Rosenberg, from a meso-meteorological analysis of radar weather observations in relation to the passage of cold fronts, showed that the use of a single radar in this way can lead to a worth-while improvement of short-term (two to six hours) weather forecasts for the local region.

If a criticism of the conference as a whole may be ventured, it is that too many papers (some sixty in all) were presented. It might have been more profitable if a more careful selection of papers to be read had been made, thus allowing more time for general discussion.

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SIXTH INTERNATIONAL CONGRESS OF MICROBIOLOGY, ROME

REPORTS OF SYMPOSIA

THE papers presented at four of the six symposia held at the Sixth International Congress of Microbiology, Rome, have been published as supplements to the *Rendiconti dell'Istituto Superiore di Scienze**. The volume dealing with the Actinomycetes contains thirteen papers dealing with the morphology, classification and general biology of the group and will be of interest mainly to specialists. It includes three papers from S. A. Waksman's team at Rutgers University dealing with the subject from the antibiotic point of view, and one by H. G. Thornton and F. A. Skinner discusses the antagonism between Actinomycetes and other organisms in soil. D. Erikson contributes a study of mycelial variation. Views on classification are expressed by P. Negroni, A. R. Prevot, H. L. Jensen, G. Penso and E. Baldozi and his co-workers.

The volume on bacterial cytology is notable not only for its written content but also for the many excellent electron micrographs illustrating the papers. Special mention must be made of a hitherto unpublished photograph of a section of *Bacillus cereus* made by G. B. Chapman and J. Hillier, which illustrates Stuart Mudd's introduction, and the pictures accompanying W. van Itersson's paper on flagella. K. A. Bissett discusses the nature and importance of the cell envelope. Nuclear structures are dealt with in papers by E. Kellenberger, E. D. Delamater and R. G. E. Murray. S. Mudd presents his views on bacterial mitochondria, which are challenged by A. Winkler in another paper.

The third symposium, on microbial metabolism, contains important papers on protein synthesis by E. F. Gale and by J. Monod and M. Cohn, and a most interesting report on the study of *E. coli* metabolism from a genetic point of view by B. D. Davis.

It is a little unexpected not to find any discussion of protein metabolism included among the papers on interaction of viruses and cells, and most disappointing to find no illustrations of R. W. G. Wyckoff's views on electron microscope evidence of

virus proliferation. P. Lepine's paper is, however, very well illustrated with electron micrographs of ultra-thin sections of virus-infected cells, although perhaps not all virologists will agree with his interpretation of them. More controversial is G. Penso's postulated life-cycle of a mycobacteriophage. R. Dulbecco's account of his studies of animal viruses in tissue culture by his phage technique will be read with interest by all virologists, as will P. von Magnus's paper on incomplete forms of influenza virus. Plant viruses are discussed by F. O. Bawden, N. W. Pirie, and K. M. Smith and N. Xeros, while J. G. Carr contributes a short outline of the problem of virus reproduction in relation to cancer.

NATIONAL SCIENCE FOUNDATION

REPORT FOR THE YEAR 1952-53

IN the report of the United States National Science Foundation for the year ended June 30, 1953*, details are given of the support that the Foundation is continuing for three general long-range surveys of fields of science which are planned to require up to three years to complete. The survey of physiological science is being conducted by the American Physiological Society, and the final report is expected in the autumn of 1954. That of the development and status of psychology is being conducted by the American Psychological Association and comprises two major parts: an evaluation of the status of psychological knowledge, with special reference to general scientific methodology, development of theory, and dependence upon empirical laws; and an analysis of occupations in psychology, including the supply, demand and utilization of scientific manpower in the various branches of the science. The survey of applied mathematics is being conducted under the direction of the National Research Council Committee on Training and Research in Applied Mathematics in co-operation with the Defense Department.

Jointly with the universities, scientific societies and other government agencies in the United States, the Foundation sponsored eight conferences during the year, covering astrophysics, photosynthesis, the abundance and distribution of elements, high-energy physics, fibre bundles and differential geometry, methods of determination of steroids in blood and urine, specificity in development, and Lie groups and Lie algebras. Other conferences, symposia or meetings sponsored by the Foundation dealt with physics research in colleges, education in physiological science and the production and use of technical reports. Responsibility for maintaining a register of scientific and technical personnel in the United States was transferred from the Office of Education to the Foundation on January 1, 1953, and with financial assistance from the Foundation some ten to twelve scientific societies are setting up comprehensive registers which by June this year are expected to cover essential information on about a hundred thousand scientific workers and engineers. Registers for all main fields of science should be established by June 1955, and meanwhile information already collected is being analysed and reports are being prepared on specific scientific fields. The present report gives

* Vito Congresso Internazionale di Microbiologia. Actinomycetales, Morphologia, Biologia e Sistematica; pp. 231; 20s., or 1,000 lire. Ottologia Batterica; pp. 181+46 plates; 25s., or 1,000 lire. Metabolismo Microbico; pp. 143+1 plate; 12s. 6d., or 1,000 lire. Rapporti tra Virus e Cellule Ospite; pp. 110+33 plates; 15s., or 1,300 lire. (Rome: Fondazione Hummel Paterno. Oxford: Blackwell Scientific Publications, Ltd., 1953.)

* The Third Annual Report of the National Science Foundation. Year ending June 30, 1953. Pp. vi+110. (Washington, D.C.: Gov. Printing Office, 1953.) 40 cents.

an analysis of the type of employment of American scientists in 1951 and of their average annual salary.

Of 1,320 who obtained the degree of Ph.D. in mathematics, 88.0 per cent went into educational institutions, 6.1 per cent into government service and 5.9 per cent went into industry. For other subjects the statistics relate to Ph.D.'s and B.Sc.'s and are interesting in that the figures for the latter show a marked preponderance for industry as against educational institutes. The numbers, with the percentages going to educational institutes, government service and industry shown in brackets, are as follows: chemistry Ph.D.'s 11,568 (32.5, 7.4, 60.1) and B.Sc.'s 25,086 (4.8, 8.6, 86.6); chemical engineering Ph.D.'s 854 (30.1, 2.7, 67.2) and B.Sc.'s 8,251 (0.7, 4.1, 95.2); and physics Ph.D.'s 2,784 (58.4, 10.7, 30.9) and B.Sc.'s 1,365 (21.4, 23.9, 54.7). Average annual salaries were highest for graduates in chemical engineering; they were about equal for graduates in chemistry and in physics, with mathematics and psychology appreciably lower and approximately equal. Except for physics, where salaries in Government service and in industry, at least at the doctorate level, tended to be equal, average salaries were highest in industry and lowest in educational institutions.

During the year the Foundation made 173 grants totalling 1,698,150 dollars for the support of basic research in the biological, medical, mathematical, physical and engineering sciences at 85 institutions. Seventy-two of these grants, totalling 798,800 dollars, were for biological and medical research, and a hundred, totalling 866,550 dollars, were for research in the physical, mathematical and engineering sciences, chemistry (28, totalling 206,500 dollars) and physics (22, totalling 282,400 dollars) receiving the greater part. The conference on physics research in colleges, already noted, recommended that, in evaluating proposals, besides the intrinsic significance of the proposed research, emphasis should be placed on the probable value of the project to the educational work of the institution. It was also suggested that projects which involve the participation of students should be encouraged and that due weight should be given to the promise and ability of the principal investigator.

In further illustration of the Foundation's understanding of basic research, the report gives a number of examples of investigations currently supported. Of the type involving observation and description are B. Maguire's exploration of the botanical resources of the Guayana Highland of British Guiana, S. D. Durrant's study of mammals on the Aquarius Plateau in the Henry and Abajo Mountains of Southern Utah, and T. H. Bullock's study of the pit organ of pit vipers. Among investigations concerned with the development of tools and instruments are M. Jakob's study of bubble formation, heat flow and other aspects of boiling, explorations of the upper atmosphere at the Ionosphere Research Laboratory, Pennsylvania State College, and the construction and operation of a radio telescope at Harvard College Observatory, under the direction of B. J. Bok. In the field of measurement, grants have been given for investigations of an unchanged component of cosmic radiation called *N-rays*, believed to be mostly high-energy neutrons. Several research projects which involve the design of suitable models for dealing with difficult problems were also being supported: these include a laboratory model of the photosynthesis of sugar and cellulose and of the biochemical reactions

responsible for the luminescence of fireflies. Grants for the development of concepts include one for the development of a new conceptual basis for probability, and those for testing concepts include a grant to study regeneration of tissue (particularly to attempt to find a growth-inhibiting substance in the adult tissue) and one to test the assumption that cosmic radiation has been constant during the past thirty thousand years by measuring the radioactive carbon content in sediments at the bottom of the ocean.

Of the 557 fellowships awarded for the academic year 1953-54, 42 were made to post-doctoral candidates and 175 to those who had received awards in 1952-53; 180 went to first-year graduate students, 166 to those in their second year, and 169 to those in their final pre-doctorate year. Chemistry claimed 129 fellowships, physics and astronomy 115, engineering 63, mathematics 56, zoology 38, biochemistry 35, geosciences 26, botany 19, microbiology 18, geophysics 14, medical sciences 14, genetics 11, psychology and anthropology 10, and agriculture 9. In view of the increasing number of applications (3,300 as against 3,000 in 1952-53) the Foundation published an 'honourable mention list' of 1,274 applicants.

During the five years 1948-52, bachelor's degrees in science, engineering and agriculture totalled about 95,000 a year, and doctor's degrees in the same fields 4,660; for 1953-57 the comparable estimates are 66,800 and 5,420, respectively; but it is expected that the downward trend will be reflected in doctorate awards from 1956 onwards. Graduate enrolment at the first year in all fields of science fell from about 12,000 during 1951-52 to about 8,000 during 1952-53. So far, the Foundation has not asked Congress for funds to support a scholarship programme but is attempting to increase the supply of young scientific workers by improving the teaching of science. The Foundation has also established an Advisory Panel on Scientific Information, and preliminary inquiry suggests that the most important information in unclassified research reports reaches scientific workers through established publication channels.

ROYAL SCOTTISH FORESTRY SOCIETY CENTENARY VOLUME

THE Royal Scottish Forestry Society is the oldest forestry society in Great Britain (the English Society having been founded in 1881), and this year it is celebrating its centenary. In honour of the occasion, the Society proposes to issue four special numbers of its journal, *Scottish Forestry*, as a centenary volume, each number containing three articles which will deal with all the aspects of forestry, and the first of these numbers has recently been published (*Scot. For.*, 8, No. 1; January 1954). It opens with centenary greetings from the president of the Society and of the English Society, the chairman of the Forestry Commission, Lord Radnor, the chairman of the Empire Forestry Association, and the president of the Society of Foresters of Great Britain, and then goes on to the three articles: the history and activities of the Society, 1854-1953, by the honorary secretary of the Society, Sir Samuel Strang Steel; forest policy and legislation affecting Scotland, 1854-1953, by Sir Henry Benceford Pierce,

of the Forestry Commission; and private forestry in Scotland, by Sir John Milne Home.

The first article recalls how the original president of the Society was James Brown, at that time deputy surveyor of the Forest of Dean and provisional head forester of Armiston, who is chiefly known as the author of "The Forester", the standard book on forestry at that period. The Society was formed by a strong committee of nineteen which framed its constitution and its by-laws, subscriptions and so forth. Members were soon forthcoming, and the first *Transactions* of the Scottish Arboricultural Society, as it was then called, appeared four years later. During the past century the Society was constantly pressing the claims of forestry in Scotland on the Government, and committees and commissions were appointed by the House of Commons, without, however, much practical result until the present century.

In Sir Henry Beresford Pierce's well-informed article he points out that it was the Society (and, in particular, Munro Ferguson, afterwards Lord Novar, Sir John Sterling Maxwell and Lord Lovat) which pressed the Government to form a model State forest to be a pilot scheme to a much larger proposal that the Society put forward, namely, the afforestation of between three and four million acres in Scotland. As a practical outcome of this suggestion, the Royal Commission on Coast Erosion in 1909 proposed alternative schemes for the afforestation of nine million or six million acres in the United Kingdom. It was the First World War which eventually brought these ultimate schemes to a head in the Aoland Report and the Government Bill forming the Forestry Commission at the close of the War.

The Society may be congratulated on the proposed centenary volume, for in that should be assembled the true forestry history of the period and the ideas which make for an appreciation of what forests and forestry really imply to a country and its people.

E. P. STUBBING

ADAPTIVE CHANGES IN SUNFLOWER

G. E. BLACKMAN AND G. L. WILSON have continued their physiological and ecological analyses of plant environment by investigating the adaptive changes in the vegetative growth and development of *Helianthus annuus* as induced by alterations in light-level (*Ann. Bot.*, 18, No. 69, 71; 1954). To this end pot experiments were carried out in which sunflowers in the early vegetative phase were first grown for a period under three levels of light (1.0, 0.5 and 0.24 daylight). Afterwards, pots from each light-group were subdivided into three so that in a second period plants could be subjected to the nine possible combinations of the same three light-intensities before and after transference. During the post-transference period of adaptation to either a higher or a lower intensity the net assimilation-rate was found to be logarithmically proportional to the light received and there was no residual effect of the initial light treatments. Eight days after transference the leaf-area ratios (total leaf area/total plant weight) at each light-level became adjusted to a new equilibrium irrespective of the large initial differences in the ratio induced by the pre-transference intensities. In both periods there was an inverse and logarithmic relationship between the leaf-area ratio and falling

light-intensity; consequently, the greater the degree of shading in the pre-transference period, the higher were the mean ratios in the second period. Since the relative growth-rate is the product of the net assimilation-rate and the leaf-area ratio, the variations in the leaf-area ratio in the post-transference period induced by the initial light treatments were reflected in the relative growth-rates. Thus plants transferred from a lower to a higher light-intensity were leafier and initially grew faster than plants maintained at the higher level in both periods: the converse conditions led to a reduction in the growth-rate.

It was observed that shading depresses the growth of the roots, but that the relative growth-rate is dependent on the light-intensity in both the pre-transference and post-transference periods. The growth-rate was maximal when plants were moved from the lowest to the highest intensity.

In terms of leaf weight, decreasing the light-intensity decreased the relative growth-rate and there was no consistent after-effect of the initial light treatments. The rate of expansion in leaf area tends to be highest at the intermediate level of 0.5 daylight, and over all the post-transference intensities the rates were maximal for those plants which received initially full daylight. The ratio of leaf area to leaf weight was inversely and logarithmically proportional to the light-level. After transference, the slopes of the regressions were independent of the initial light treatments; but the mean ratios were inversely correlated with the initial degree of shading. These observations are discussed with particular reference to the control of growth exerted by growth-regulating substances: on the basis of existing knowledge, no adequate interpretation of the adaptive changes yet seems possible.

DISTRIBUTION OF LAMINARIACEAE AROUND SCOTLAND

By F. T. WALKER

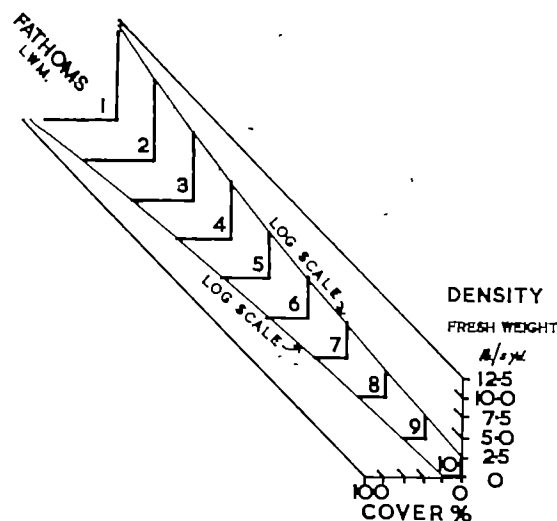
Institute of Seaweed Research, Musselburgh, Midlothian

FIFTY-NINE detailed surveys, covering 80,000 acres of the sub-littoral zone off the north-east, south-east and south-west mainland of Scotland, the Isle of Skye and several of the islands of Orkney, have been completed by the Botanical Division of the Institute of Seaweed Research.

The detailed surveys were preceded by aerial photogrammetric surveys. They were carried out at all times of the year and during seven years, 1946-53, and so include seasonal and cyclic changes. They covered areas of the sea-bed from low-water mark down to ten fathoms (19 m.), where the dominant species was either *Laminaria cloustoni*, *L. digitata* or *L. saccharina*. (Some surveys were restricted to depths of 1-6 fathoms.) Tidal streams ranged from 0 to 7 knots and tides from low-water mark to 3 fathoms (6 m.) according to time and location.

In the course of the fifty-nine surveys, operated from motor-vessels, some 50,000 quadrats were taken from the sea-bed by means of calibrated spring-grabs which close by trigger action on reaching the bottom.

The 1946-49 surveys employed methods of quadrat sampling along transects measured by range-finder,



The master means of fresh weight (vertical lines) and percentage cover (horizontal lines) of *Laminaria* found at 1-10 fathoms low-water mark ordinary spring tides, from the data of 59 surveys around Scotland between May 1946 and September 1953

while for the 1949-53 surveys, random sampling was used. Random sampling is less dangerous inshore; nevertheless, this method can attain considerable accuracy: standard errors of 1-2 per cent of the mean, when the intensity of sampling is only 100 quadrats per square kilometre, have been achieved.

The mean of the means (which we term the master mean) of 'density' and 'cover' found at each depth for the fifty-nine surveys is given in Table 1 and in the accompanying figure.

Density is the average fresh weight of *Laminaria* per unit area based on quadrats which contained these algae. Cover is the number of quadrats which contained *Laminaria* expressed as a percentage of all quadrats.

From the above data, several conclusions may be drawn. First, it will be found that the value for density divided by the respective value for cover is a good approximation to a constant (13.14) for each fathom interval of depth of 1-10 fathoms. The density/cover values for the ten depths have a standard deviation of 0.9 and a standard error of 2 per cent from the constant. The fresh weight of *Laminaria* is therefore proportional to the percentage cover. This relationship has been reported for many individual surveys²⁻⁴.

Secondly, the seaweed densities given in Table 1 follow an exponential scale. The regression of this scale with increasing depth calculated on $\log_{10}$ is $1.1600-0.0770$ per fathom, from 1 to 10 fathoms, low-water mark ordinary spring tides. As the cover

Table 1

Depth Low-water mark ordinary spring tides (fathoms)	Density		Cover Master mean of 59 surveys (per cent)
	Master mean of 59 surveys (based on quadrats with <i>Laminaria</i>)		
	(lb./sq. yd.)	(kgm./sq. m.)	
1	11.0	6.0	76
2	10.8	5.6	72
3	8.8	4.8	65
4	7.5	4.1	57
5	6.2	3.3	48
6	5.3	2.9	44
7	4.7	2.5	35
8	3.8	1.8	28
9	2.7	1.5	21
10-1	2.3	1.2	18

Table 2

Depth Low-water mark ordinary spring tides (fathoms)	Cover Master mean of 59 surveys (per cent)	Standard deviation of mean density Master mean of 59 surveys	Standard deviation Cover
1	68	5.20	7.6
2	66	4.73	7.3
3	58	4.30	7.4
4	51	3.68	7.1
5	45	3.07	6.8
6	39	2.43	6.2

is proportional to the density, then the cover must be exponential also with depth.

Seaweed growth is the result of photosynthesis. If light be the limiting factor we would expect the growth of *Laminaria* to be exponential with increasing depth, for the coefficient of extinction of the visible solar spectrum is also logarithmic through water.

The 'coefficient of extinction of *Laminaria*', based on the exponential scale $\log_e$, equals 0.096 per metre interval of depth.

The area covered by the species of *Laminaria* has been shown above to be proportional to the density or fresh weight at various depths; cover, then, should be proportional to the standard deviation of the mean density where the frequency and the spread of the quadrat weights follow normal distributions.

The standard deviation of the mean density has been calculated for twenty-eight of the surveys, carried out between 1949 and 1953, when random sampling was employed. The master means against the corresponding values for cover are given in Table 2 from 1 to 6 fathoms.

It will be found that the values in Table 2, col. 4, equate as follows: standard deviation of the mean divided by the percentage cover equals $3.1-0.3$ fathom (± 3 per cent), or the standard deviation is closely proportional to the cover. From this it may be concluded that the algal cover is conditioned by the frequency and spread of the algae, which in turn are the result of photosynthesis-reproduction-dispersion; while the nature of the substrate plays an important part in the establishment of algae, the areas under review were selected because they did support prolific laminarian growth.

In more recent surveys the number of plants per quadrat has been recorded, and the decrease in seaweed density has been found to be more the result of a reduction in the number of plants per unit area than of the weight of individual plants. It follows that with increasing depth the total spore production will be decreased, dispersion and fertilization will be restricted and the plant cover limited.

This last conclusion requires the development of the spores to proceed at approximately the same depth of sea as that at which the parent plant is or was growing.

Time has been available for the analysis of only a limited number of surveys by the application of the chi-squared test to samples and their distributions. The data of some surveys fit normal distributions admirably, others do not. For example, a survey carried out between Girvan and Bannane Head in the approaches of the Firth of Clyde during May 1952 indicated that the frequency and spread of the samples had a normal distribution at all depths from 0 to 6 fathoms. An identical survey, carried out in the following October-November after severe gales had

reduced the total quantity of seaweed by more than 34 per cent, showed the samples no longer conformed to normal distributions when the χ^2 test was applied.

The aerial survey of the sub-littoral zone of Scotland (begun in 1945) in conjunction with the results of the detailed surveys have enabled me to assess the total laminarian growth from aerial photographs taken by the Royal Air Force, to which grateful acknowledgment is made for its co-operation.

The first assessment was made in 1950, and a reassessment in 1954 shows no extensive changes, although it is now known that cyclic changes are occurring. These will be reported later.

The marine coast of Scotland and Islands is 5,300 miles; the sub-littoral zone from low-water mark to a depth of ten fathoms is two million acres; over this area, with considerable variation in seaweed density, grows 10 million tons (fresh weight) of Laminariaceae. Of this quantity, 3-4 million tons are concentrated in quantities of economic value.

[Jan. 18.

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UPTAKE OF RADIOACTIVE CARBON AND PHOSPHORUS BY PARASITIZED LEAVES

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THE arbitrary nature of the distinction between 'obligate' and 'facultative' parasites on plants has long been recognized, as well as the possibility that advances in knowledge might lead to the successful culture of the former, including rusts and mildews, on artificial media¹. Indeed, this has apparently now been accomplished in the case of *Gymnosporangium juniperovirginianae* Schw., a rust producing telial galls on *Juniperus*². Nevertheless, relatively little is known about the physiology of rusts and mildews and their effects on host metabolism, or of the physiological basis of resistance to them. Both obligate and facultative parasites cause marked increases in the respiration of the host tissues, even at considerable distances in advance of the invading mycelium, a phenomenon which may be attributed to the production of diffusible substances by one or both members of the host-parasite complex³. Eventually photosynthesis is reduced, and there is usually a visible chlorosis in the area of infection. An outstanding characteristic of rusts and mildews on cereals is that increased respiration⁴ and decreased photosynthesis are accompanied, in the earlier stages of disease, by increases in hexose, sucrose, starch⁵, free amino-acids⁶ and, to judge from the occurrence of oil droplets, possibly in

lipid content as well. Often the only starch to be found in the mesophyll of wheat leaves occurs as a deposit around infections of these fungi. Under optimum conditions, the host tissue at infection sites flourishes long after the remainder of the leaf is moribund, and there may even be a resynthesis of chlorophyll⁷, leading to the formation of the characteristic 'green islands'.

Gottlieb and Garner⁸ demonstrated the movement of phosphorus-32, supplied to the culture solution as phosphate, to infections of *P. graminis* on wheat. In their experiments the plants were exposed to the isotope for several days. The specific activity of the ureidospores was less than that of either healthy or infected leaf tissue. Yarwood and Jacobson⁹ described the preferential absorption of sulphur vapour by infections of *Uromyces phaseoli* on bean and sunflower and *Erysiphe polygoni* on bean after eight-hour exposures to sulphur-35. The treatment was lethal to the fungi but did not damage the leaves.

The isotope technique appeared to offer an approach to the investigation of the relation between diseased and healthy tissue on the same leaf. Accordingly, we examined the effect of infection with a number of facultative and obligate parasites as well as of mechanical wounding on the distribution of phosphorus-32, supplied as phosphate, and of carbon-14, fed to the leaves as carbon-14 dioxide or sugars (glucose-1 ¹⁴C, ribose-1 ¹⁴C, xylose-1 ¹⁴C) under a variety of conditions. The sugars and phosphate were introduced either by localized injection of attached leaves or by standing the cut-leaf bases in 0.25 per cent (w/v) solutions in distilled water or phthalate buffer at pH 5.5 for from 20 min. up to 24 hr. The leaves were then killed between hot metal plates, pressed and autoradiographs prepared using Kodak No-Screen X-ray film.

In uninfected leaves fed with labelled sugars or phosphate, tissue wounded by pricking or removing the epidermis was sometimes as active as that in undamaged areas, but usually less so. No tracers entered areas which were actually dead. Similarly, no activity entered or accumulated around the lesions produced on *Vicia faba* by *Botrytis* sp., which kills the host tissue in advance. Moderate accumulation was observed in young infections and around, but not within, older infections of *Pseudomonas medicaginis* f. sp. *phaseolicola* (Burkholder) Dowson, on *Phaseolus vulgaris*. There was no accumulation in young infections of *Helminthosporium* sp. on wheat and actually less radioactivity (from glucose) in young lesions produced on oats by *Pseudomonas coronafaciens* (Elliott) Stapp than in surrounding healthy tissue. After 20 hr. a diffuse zone of increased activity was observed around old, large, lesions of *Helminthosporium* on wheat, as at the edges of cuts made transversely across the lamina. In short, the results obtained with these facultative parasites showed a general similarity to those obtained by the mechanical wounding of healthy tissue. It is clear, however, that the range of facultative parasites investigated should be extended to include types more closely approaching obligates in their behaviour.

The results obtained with rust (*P. graminis* on wheat and barley and *P. helianthi* on sunflower) and mildew (*Erysiphe graminis* on wheat and barley) were more striking than those described above. From an early stage (3-4 days after inoculation) of development on susceptible hosts, there was a rapid and marked accumulation of radioactivity at infections of these obligate parasites, as illustrated in Figs. 1-2

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Figs. 1-2. Autoradiographs of excised wheat leaves with 12-day old infections of *P. graminis*. At this stage of development the starch deposit lies outside the secondary uredinia (see Fig. 6). (1) After feeding 0.25 per cent xylose-1 ^{14}C for 45 min. (2) After 165 min.; the activity is concentrated beneath the uredinia. In all figures light areas indicate high activity.
Figs. 3-5. Autoradiographs of sunflower leaves, bearing 8-day old infections of *P. helianthi*, exposed to carbon-14 dioxide for 3 min. at a light intensity of 500 f.c. Total concentration of carbon dioxide approximately 0.03 per cent. (3) Killed immediately. (4) Killed after standing in a normal atmosphere for 20 min. (5) Killed after 4½ hr.
Fig. 6. Starch formation in wheat leaves infected with *P. graminis*. The leaves were cleared in alcohol and stained in aqueous iodine

for *P. graminis* on wheat. Identical results were obtained with glucose, ribose and xylose and phosphorus-32. Following exposures to carbon-14 dioxide in the light for 0.5-3 min., leaves were killed immediately, and also after standing in a normal atmosphere for varying periods of time. Autoradiographs revealed the effect of the parasite in depressing photosynthesis in the invaded host tissue and the subsequent influx of fixed carbon-14. A typical result is shown in Figs. 3-5 for *P. helianthi* on sunflower.

By removal of the ectoparasitic mycelium of mildew both before and after exposure to the isotopes, it was possible to demonstrate that the bulk of the accumulated activity was in the mesophyll of the host, beneath the fungal mycelium. Moreover, accumulation was not detectably impaired by removal of the mycelium prior to the experimental treatment. The 'active' nature of the process is emphasized by the results of preliminary experiments with both rust and mildew in which marked inhibition was obtained with phloridzin (1 mM) and dinitrophenol (1 mM) in phosphate buffer⁹ at pH 5.5. Little inhibition was observed with azide (10 mM) under these conditions. Allen and Goddard¹⁰ reported that the mildew-stimulated respiration of wheat was insensitive to azide, which did, however, inhibit the respiration of the fungus itself.

Accumulation was much more pronounced with susceptible- than with resistant-type infections of rust and mildew. This cannot be regarded merely as an expression of the degree of utilization of substrate by the parasite, since the increase in activity is mainly in the mesophyll of the host. Similarly, under summer greenhouse conditions starch was deposited in association with susceptible but not with resistant infection types. Even with the former, no starch formed under winter greenhouse conditions at Saskatoon. Starch formation, formerly attributed to a breakdown in translocation¹¹, is probably also the result of translocation to the infection. An interesting point is that, in the case of rust, the starch is deposited as a very distinct ring. In young infections this closely surrounds the uredinia but later becomes separated from them by a starch-free zone (Fig. 6).

It is essential for successful obligate parasitism that substrates be supplied to the invaded cells at a rate high enough to maintain their organization and metabolism in the presence of the parasite, which cannot exist on dead tissue. Whether or not the parasite obtains an adequate supply of substrate for

continued growth must depend on the relative rates of utilization and supply (transport) of substrate. It may be imagined that in resistant hosts the latter limits the growth of the fungus initially, and that subsequent exhaustion of the invaded host cells and suboptimal nutrition of the fungus result in the formation of metabolic products, by one or both members of the complex, which would not otherwise be formed in critical amounts. These may well be toxic to either or both parasite and host. Injury to the invaded host cells may also stop all translocation to and from surrounding healthy areas, as is the case with at least some facultative parasites. A parasite-induced increase of permeability of the type reported by Thatcher¹² does not appear capable of explaining the active transport described here.

Our observations support the hypothesis that a substance (or substances) diffusing from the site of infection alters the normal metabolism of the host tissue. The concentration of this substance, as controlled by rates of production, breakdown or inactivation, and diffusibility, may be regarded as governing the rate at which metabolites move into the infection from surrounding areas and thus the supply of substrate to both parasite and parasitized cells. It seems apparent that the rate of movement of substrates both toward and away from the primary infection must play an important part in determining susceptibility to disease, at least in the case of obligate parasites.

These observations, which will be published in detail elsewhere, form part of a programme of research on the physiology of parasitism financed by grants (to M. S.) from the Department of Agriculture and the National Research Council. We are grateful to Dr. A. O. Neish for providing the labelled sugars, to Prof. J. W. T. Spinks for a gift of phosphorus-32, and to Dr. W. A. F. Hagborg for cultures of the bacterial pathogens. [Dec. 31.]

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Science Teachers in Schools

As a member of the Appleton Committee considering the shortage of teachers of science and mathematics in Scotland, I have read with very great interest the editorial comments in *Nature* of January 30, p. 177. I have found the comments of great interest and value. There is, however, one small passage of which the implication is not too clear. The passage in question states: "Are not these small science sixth forms due partly to the fact that some of the science teachers are of such moderate ability and personality that they cannot attract any more pupils to their side of the school, and partly to the fact that, where the teacher is competent, he has already attracted all the pupils capable of doing sixth-form science?"

Surely the two possibilities visualized here are rather contradictory. In one case it suggests that the smallness of the science classes is due to incompetence on the part of the science teachers. If this is the case, the obvious solution is to improve the quality of the science teachers. If, however, the second possibility is true, improvement of the quality of the science teachers would be of no avail. However competent the science teacher he cannot teach the subject to pupils incapable of absorbing it, and the problem is impossible of solution. After all, you cannot make a silk purse out of a sow's ear. I may, however, have misunderstood the implication of this passage.

I also note that the National Advisory Council suggests that "the glamour of research should be counteracted by putting the case for teaching as a satisfying career to undergraduates in the pure science departments of the universities". While I agree that too many unsuitable people are attracted by the glamour of research, I am appalled by the suggestion that those responsible for advising undergraduates should be expected to pretend that teaching is a satisfying career if this is not in fact the case.

In Scotland, great emphasis is laid upon the desirability of science teachers holding first- or second-class honours. While agreeing that teachers should be of the best quality, I cannot agree that the holder of first- or second-class honours is likely to be a better teacher than a man holding a good pass degree. In fact, I feel that the honours man tends to be a narrow specialist, whereas a schoolmaster should be a man of broad general culture. It is surely not necessary to hold a first- or second-class mathematics degree to teach quadratic equations. I have been assured by a professor of mathematics in a Scottish university that it is the realization that they will not use their academic knowledge to the full which creates a reluctance of honours graduates to go in for teaching.

In conclusion, I should like to say that I heartily agree with the last paragraph of the article. Legislation on education of the past twenty years or so has

been too much the prey of the popularity-seeking politician.

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Nature's campaign to promote action on the part of the various authorities concerned with the future of science and science teaching is admirably persistent and constructive. One of the suggestions (*Nature* of February 27, p. 388) is of particular interest. It reads as follows: "If more of the graduates in arts, for example, left the universities of Britain with some sound knowledge of general science, they might well be qualified to assist in the general science teaching which is so desirable for the ordinary citizen, whether or not he proceeds beyond the grammar school or technical school level". This is an admirable idea which I should be delighted to see carried out as an educational policy; but it is well to examine the difficulties that lie in the way to see if they can be surmounted.

First of all, let us take a historical fact. More than thirty years ago, in one university at least, intending teachers entering the faculty of arts were compelled to take either mathematics or science as part of their studies if they had not included Latin in their matriculation. The result was not happy for those taking compulsory science. Lecturers and demonstrators were not particularly interested in students who were pursuing subjects that were regarded as makeweight. The students themselves felt they were intruders or 'poor whites'. The scheme was not continued. It would be folly to make further attempts along the same lines.

Secondly, let us deal with general science—an admirable conception, rarely if ever realized. If general science is ever to become, what it should become, the peer of English as the main educational discipline for children of school age, the organization will have to start in the universities; but this will need men and women imbued with the fervour and enthusiasm of a T. H. Huxley. It will need in its pioneers a combination of humanist, philosopher and scientist, together with willingness to sacrifice possible fame as scientific discoverer to the more humble reputation of teacher. If such a discipline could be instituted to reach down from the universities to the schools and outwards from the schools to all human activities, it would, in the words of the article, facilitate "the absorption of science into the general culture . . . and it would also assist the graduate science teachers to concentrate more on the sixth forms or the teaching of those with a scientific career in mind". However, it is unlikely to succeed unless general science becomes as important in general esteem as particular scientific studies.

The arts graduate is already in danger of becoming a poor relation because the science graduate is attracting an inordinate proportion of special posts in the schools. This regrettable tendency to devalue the arts degree is already having unhappy results and can lead only to ill-effects on our general culture.

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Solar Radio Asymmetry at 4-Metres Wave-length

In 1948, Hey, Parsons and Phillips¹ reported that at 4.1-metres wave-length bursts of radio emission, usually of a few minutes duration, occurred more often in association with flares on the eastern half of the sun's disk than on the western half. Subsequent observations have confirmed this conclusion. In a recent analysis of radio emissions at 1.5-metres wave-length, Dodson, Hedeman and Owen² could find no evidence of this asymmetry. The following reasons may explain why they failed to observe the effect.

Hey, Parsons and Phillips¹ suggested that the asymmetry they had observed might be due to radio absorption in ionized solar corpuscular streams, as the rotation of the sun causes the envelopes of such streams to drift eastwards relative to the active solar regions from which they emanate. They also pointed out that the longer the wave-length, λ , the greater would be the expected absorption. That this anticipated property provides a test of the absorption theory was emphasized by Unsöld and Chapman³.

As the absorption coefficient is proportional to λ^2 , it is approximately 7.5 times greater at $\lambda = 4.1$ metres than at $\lambda = 1.5$ metres. Further, if the electron density in the stream is sufficient, the refractive index, μ , may be appreciably less than unity at long wave-lengths, and the absorption coefficient would again be increased since it is inversely proportional to μ ; in addition to this, refraction might be expected to diminish radio intensities in the direction of the ionized streams by deviating the long radio waves out from them. It is consequently to be expected, on the hypothesis that solar radio asymmetry at $\lambda = 4.1$ metres is due to asymmetrical absorption in an ionized stream, that the asymmetry might be difficult to detect at the shorter wave-length of 1.5 metres. The results reported by Dodson, Hedeman and Owen are therefore in accordance with this hypothesis, although the conclusion can scarcely be regarded as decisive yet as they analysed only about two hundred flares with associated radio measurements during 1948-50, whereas we found that ten times this number of observations obtained during 1947-50 were only just sufficient to establish the significance of the asymmetry at $\lambda = 4.1$ metres at the 5 per cent level of chance probability.

Additional data at $\lambda = 4.1$ metres obtained during part of 1948 and the first half of 1951 have increased the significance of the asymmetry observed at this wave-length. It is unfortunate that, owing to interference and other circumstances, radio measurements had to be discontinued in 1951, because a striking feature is the pronounced increase in the asymmetry during the second half of 1950 and the first half of 1951, just when the recurrent *M*-type magnetic storms were becoming prominent. This suggests the intriguing possibility that continuous *M*-type corpuscular streams may be more effective in producing absorption than are the spasmodic bursts of corpuscular emission from active flare regions.

A detailed analysis of the radio asymmetry with respect to terrestrial magnetic activity is now in progress. It is hoped that this may be decisive in establishing whether or not the interpretation in terms of the absorption of a corpuscular stream is correct. There is so little direct evidence of solar corpuscular streams, and especially of the nature of

solar *M*-regions, about which there is yet uncertainty whether the terrestrial magnetic activity might be due not to corpuscular streams but to ultra-violet radiation, that any evidence which can be derived from radio phenomena is of importance.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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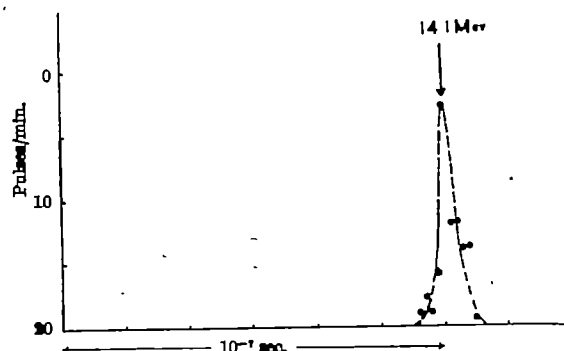
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Time of Flight of 14.1-MeV. Neutrons

THE essential problem in utilizing the time of flight of fast neutrons for energy measurements is the rapid fall-off in efficiency of detection as the flight path *D* is increased, since the resolution is proportional to *D*, while the efficiency is proportional to *D*⁻². It is therefore desirable that a multi-channel time spectrometer be used when a neutron momentum spectrum is being analysed.

One such instrument is the high-speed triggered oscilloscope in which the first pulse triggers off the time base and the second pulse is displayed on the 'y' plates. Using a new form of high-speed time base and low-level trigger circuit¹, the group of pulses due to the 14.1-MeV. neutrons from the reaction ⁴He(*d*, *n*)⁴He has been analysed. A full account of the technique will be published later; but it is felt that a preliminary indication of the feasibility of the method and indeed of the accuracy of the analysis even with such high-energy neutrons will be of interest. The graph shows the number of pulses falling in each division of the time base which is triggered from the recoil ⁴He detected in a stilbene crystal. The neutrons travel about five metres and into six cubic inches of toluene/terphenyl solution. By moving the toluene bottle towards the target, the shift observed in the peak is in agreement with that calculated from the neutron energy. The optimum resolution is less than 10 μ sec.² and is obtained by adjusting the biases on the two low-level discriminators. At this setting most of the neutron pulses overcome the bias.

Although the high-speed time-base is invaluable in setting up the apparatus, it is tedious to estimate the



time distribution on it. An electronic circuit is therefore being developed to convert a time spectrum into a voltage spectrum, which will then be fed into a multi-channel kick-sorter.

I am indebted to Dr. P. J. Grant, Dr. J. G. Rutherglen and Mr. J. Fraser for their generous assistance in using the Glasgow University Physics Department high-tension set.

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A Proton Magnetic Resonance Study of the Hydration of Deoxyribonucleic Acid

DILUTE solutions of deoxyribonucleic acid have high viscosity, very large increment of dielectric constant and high osmotic pressure. It has been suggested that these properties result from the formation of large hydration shells with a higher degree of lattice order than that prevailing in pure water¹. In order to investigate these phenomena further, we have studied proton magnetic resonances of some deoxyribonucleic acid solutions and gels.

Two high polymeric preparations of sodium deoxyribonucleate (according to the method of Gulland *et al.*²) were investigated in concentrations of 0.06–80 per cent by weight. For comparison, 1.6 per cent solutions of haemocyanin (*Helix pomatia*), soluble starch and egg albumin were also studied. Proton magnetic resonances were observed in a magnetic field of about 7,050 gauss with a resolution of three parts in 10⁷. Resonances were displayed on the screen of an oscilloscope and photographed (Fig. 1), and the areas of the traces of the absorption mode were measured³.

The normalized area measurements (col. 2 in Table 1) are representative of the fraction of the water protons which contributes to the signal within a line width of about 15 milligauss. The remaining fraction (col. 3) of the protons has a resonance line that is so broad that it does not contribute to the area measured. (The more concentrated solutions of deoxyribonucleic acid gave resonances the visible line width of which, while noticeably greater than that of pure water, was still less than 15 milligauss.) The broadening of the line may be due to several causes; the most likely in this case are increased order of the water lattice and exchange of protons or water molecules between ordered and disordered phases of the water.

For haemocyanin, starch and egg albumin, the resonance lines were almost identical with the lines for pure water, and no broadening or decrease in

Table 1

Concentration (weight, per cent)	Area per gm water in sample (arbitrary unit). Accuracy, ± 0.06	Fraction decrease of area*	Fraction decrease per conc. unit nucleic acid
Water	1.00	0	
0.06 per cent sodium deoxyribonucleate	0.94	0.06	1.0
0.6 per cent sodium deoxyribonucleate	0.83	0.17	0.23
1.6 per cent sodium deoxyribonucleate	0.66	0.31	0.19
80 per cent sodium deoxyribonucleate	0.15	0.85	0.014
0.06 per cent sodium deoxyribonucleate in 0.016 N NaCl	1.00	0	
1.6 per cent sodium deoxyribonucleate in 0.04 N NaCl	0.84	0.16	
1.6 per cent starch	0.99	0	
1.6 per cent haemocyanin	1.0(5)	0	
1.6 per cent egg albumin	1.0(4)	0	

* Figure represents the fraction of the protons the resonance of which is very broad in comparison with 15 milligauss.

area could be detected. This is to be expected since the degree of hydration of these substances is known to be low.

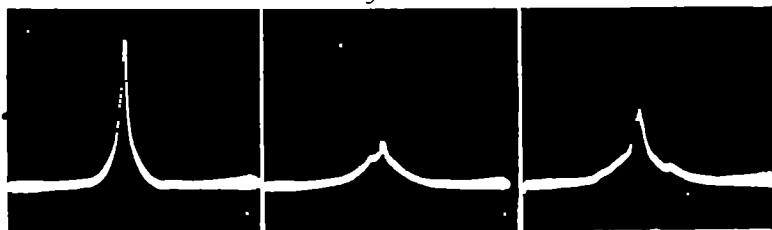
From the results for deoxyribonucleic acid, we conclude that in the hydration shells of the macromolecules there are some water molecules that have a higher degree of lattice order than that prevailing in pure water. The lattice order in the hydration shells is such that the resonances are broader than 15 milligauss. The observed line-width of pure water was 3 milligauss as determined by magnetic field inhomogeneities.

Since we do not know the amount of exchange broadening, if any, it is not possible to specify the exact size of the hydration shells from our present results. It is only possible to make the following quantitative statements. First, not less than the fraction indicated in col. 2 exists in a phase of sufficient disorder such that the lines are sharp compared to a solid phase such as ice. Secondly, the exchange, if any, between ordered and disordered phases must take more than 0.05 sec.

In principle, line-broadening could arise from a proton exchange between the water and the protons of the macromolecules. However, this effect cannot cause the main decrease in area, since there are not enough macromolecular protons present in the dilute solutions to make possible such a process. Furthermore, col. 4 indicates that an increase in concentration of nucleic acid does not result in a proportionate decrease in area.

On the addition of electrolytes to the nucleic acid solutions, considerable amounts of water previously bound are released to the normal water state, as shown by the larger values for normalized area shown in the table. This agrees well with the results obtained

from dielectric, viscosity and osmotic pressure studies, which indicate that the ordering action of the macromolecules on the water lattice is much reduced in the presence of small amounts of electrolytes. This decrease in hydration is attributed to a contraction of the macromolecules leading to an impairment of the structural fit between the macromolecular surface and the regular



Oscillographic traces for (a) pure water, (b) 1.6 per cent sodium deoxyribonucleate, and (c) 1.6 per cent sodium deoxyribonucleate in 0.04 N sodium chloride

four-co-ordinated water lattice¹. The proton magnetic resonance data support these ideas.

The dielectric method for studying water structure changes induced by macromolecules is more sensitive than the proton magnetic resonance technique. However, dielectric studies cannot be applied to solutions of high conductivity, whereas the proton magnetic resonance method is undisturbed by the presence of moderate amounts of electrolytes. This makes it possible to use the latter method for studies *in vivo*.

We wish to express our gratitude to Prof. Felix Bloch for helpful discussions, and to Dr. L. G. Allgen, Karolinska Institutet, Stockholm, for supplying one of the nucleic acid preparations.

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Synthesis of L-Amino-succinimide

In an attempt to account for the differences in the chemical and physiological properties of asparagine and glutamine, Steward and Thompson¹ have suggested that the structure of asparagine is best described by a tautomeric system the major component of which is the monohydrate of amino-succinimide, while glutamine is best represented by the conventional straight-chain formulation. This theory has been questioned by Leach and Lindley², by Katz, Pasternak and Corey³, and by others. Steward and Thompson⁴ pointed out that the synthesis of amino-succinimide and a comparison of its properties in aqueous solution with a solution of asparagine would provide unequivocal evidence either for or against their hypothesis. We wish to report the synthesis of L-amino-succinimide.

In connexion with another investigation, we observed that the attempted saponification, under mild conditions, of carbobenzoxy-L-asparagine methyl ester⁵ does not yield carbobenzoxy-L-asparagine. Instead the major product is a much weaker acid which we identified as carbobenzoxy-L-amino-succinimide, m.p. 79–81°, $pK_a = 9.1$ in aqueous methanol, $[\alpha]_D^{25} = +43^\circ$ (c. 1, 95 per cent ethanol); (calc. for $C_{12}H_{13}N_2O_4$: C, 58.05; H, 4.87; N, 11.29; amide-N, 5.65; found: C, 57.29; H, 5.17; N, 11.25; amide-N, 5.50 per cent). Carbobenzoxy-L-amino-succinimide is also obtained from carbobenzoxy-L-isosparagine methyl ester. Reaction of the imide with aqueous ammonia yields carbobenzoxy-aspartic acid diamide. Prolonged treatment of the imide with alkali at room temperature, followed by hydrogenolysis to remove the carbobenzoxy group, results in the formation of a mixture of asparagine and isosparagine.

Hydrogenolysis of carbobenzoxy-L-amino-succinimide yields L-amino-succinimide, m.p. approximately 144° (decomp.), $[\alpha]_D^{25} = +77^\circ$ (c. 1, methanol); (calc. for $C_4H_7N_2O_2$: C, 42.10; H, 5.80; N, 24.6; neut. equiv. 114; found: C, 42.84; H, 5.28; N, 24.85 per cent; neut. equiv. 118 (titrated with

acid)). Although L-amino-succinimide appears to be quite stable in the crystalline form, the compound is almost completely destroyed when a 1 per cent solution in phosphate buffer of pH 7.0 is heated for fourteen hours at 37°. Electrometric titration of an aqueous solution of L-amino-succinimide shows the presence of a weakly acidic group with $pK_a = 9.0$, the imide-group, and a weakly basic group with $pK_b = 5.9$, the amino-group. A mixture of L-asparagine and L-amino-succinimide can be separated readily by chromatography either with *n*-butanol-acetic acid-water (4:1:5) or with phenol saturated with water. It is thus clear that the properties of aqueous solutions of L-amino-succinimide and L-asparagine are not similar.

Details of these investigations are being published elsewhere⁶.

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¹ Steward, F. O., and Thompson, J. F., *Nature*, **169**, 739 (1952).

² Leach, S. J., and Lindley, B., *Nature*, **171**, 1002 (1953).

³ Katz, L., Pasternak, B. A., and Corey, R. B., *Nature*, **170**, 1066 (1952).

⁴ Steward, F. O., and Thompson, J. F., *Nature*, **171**, 1063 (1953).

⁵ Bergmann, M., and Zervas, L., *Ber.*, **68**, 1193 (1935).

⁶ Sondheimer, E., and Holley, R. W., *J. Amer. Chem. Soc.* (in the press).

In our earlier consideration of the relationships of asparagine and glutamine, substances which are of great physiological importance, we directed attention to the interest which would be aroused by an unequivocal synthesis of amino-succinimide and whether "it proved to be, when hydrated, identical or different from asparagine"^{1,2}.

Through the courtesy of Drs. Sondheimer and Holley, we have seen their paper³ and communication (above) on L-amino-succinimide in advance of their publication. They are to be congratulated on what appears to be an elegant piece of synthetic work leading to derivatives of L-amino-succinimide and to the pure substance, the properties of which are now described for the first time.

It is of great interest to us that the substance amino-succinimide: (a) is stable in its crystalline anhydrous form; (b) can exist in aqueous solution and show by its titration curve the weakly acidic imide group and a weakly basic amino-group; (c) is distinguishable from L-asparagine by its position on chromatograms, though, like that substance, it reacts brown with ninhydrin on paper; (d) is readily convertible, even by warming to 37° at pH 7.0, to a mixture of asparagine and isosparagine.

It is also of interest that in two ways, referred to by Sondheimer and Holley, there is a ready interconvertibility of the straight-chain form as it is supposed to occur in asparagine and the ring form as it occurs in amino-succinimide. This is shown by: (a) the hydrolysis of the methyl ester of carbobenzoxy asparagine yielding only carbobenzoxyamino-succinimide; (b) the combination of amino-succinimide with water to give asparagine and isosparagine.

It is granted that the evidence of Sondheimer and Holley now is that asparagine and amino-succinimide can be distinguished. The important part of their evidence, in our view, is that which describes the properties of amino-succinimide in the free state and in solution. Apparently, amino-succinimide can exist unhydrated and distinguishable from asparagine, and when it com-

binas with water, which it does very readily at 37° or above, it gives not asparagine only but both asparagine and isoasparagine. While we are grateful to Drs. Sondheimer and Holley for furnishing evidence of the kind which we ourselves would have been glad to obtain, there still remain some features of the asparagine-glutamine problem that require explanation.

Asparagine and glutamine behave differently toward ninhydrin and they also behave differently toward nitrous acid in acetic acid solution. Asparagine reacts toward ninhydrin in two distinct ways. In solution in the cold or on paper at 60° C., it reacts with ninhydrin without being decarboxylated to form a brown compound. This reaction is typical neither of the α -amino-acids nor of glutamine. (In respect to the brown ninhydrin colour, asparagine resembles amino-succinimide more than glutamine.) In hot solutions, however, asparagine, like glutamine, may be made to react with ninhydrin with decarboxylation to give a blue colour and in a manner which is typical of most α -amino-acids. In the reaction with nitrous acid, the amide group of asparagine does not react, whereas that of glutamine does.

These anomalies and interesting physiological differences between glutamine and asparagine still require to be fully explained—even though, from the work of Sondheimer and Holley, one cannot now regard L-asparagine as a simple hydrate of L-amino-succinimide.

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² Steward, F. O., and Thompson, J. F., *Nature*, **171**, 1063 (1953).

³ Sondheimer, E., and Holley, R. W., *J. Amer. Chem. Soc.* (in the press).

Hydrogen Bonding and the Volume of Water

WATER behaves approximately as a normal liquid with respect to its volume at a high temperature and pressure. The expected volume of the liquid at room temperature is obtained by extrapolation, for example, using the formula of Jacobson and Heedman¹. The volume thus deduced corresponds to a state without hydrogen bonding (at 0° C. about 8 per cent denser than ordinary water). Each hydrogen bond formed at a given temperature ($t < 174^\circ$ C.) is now assumed to affect the ideal liquid in the same way, raising the molecular volume to that of ice when two moles of hydrogen bonds are established. (Ice is supposed to exhibit the same thermal expansion above 0° C. as immediately below.)

Introducing the observed volume of water, these assumptions render possible the determination of the molecular fraction of hydrogen bonds, X , as a function of temperature. At 0° C., X is calculated to be 0.44, decreasing to 0.23 at 100° C. When no hydrogen bond is broken, the number being two per molecule, X is one.

Following Finbak², the law of mass action is applied to the formation of hydrogen bonds. The breaking of a bond gives two sites for bond formation. Thus a graph of $2 \ln(1 - X) - \ln X$ against $1/T$ was investigated. An almost straight line was obtained, corresponding approximately to an enthalpy change of 2.6 k.cal./mole water and an entropy change of 8.9 cal./mole.

A hydrogen-bond energy of 1.3 k.cal./mole seems quite low, compared with the current estimates for water. There has been no general agreement, however, on the energy of the hydrogen bond. This is probably due to difficulties in defining and sharing out the different energies. The present investigation indicates that 2.6 k.cal./mole is responsible for the tendency towards tetrahedral configuration in water. This is ascribed to the hydrogen bond. The van der Waals's energy superimposed gives only a very loose orientation effect, though it is probably partly included in most hydrogen-bond energy determinations.

A detailed discussion will appear later elsewhere.

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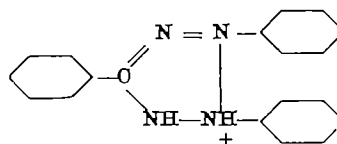
¹ Jacobson, B., and Heedman, P. A., *Acta Chem. Scand.*, **7**, 705 (1953).

² Finbak, Chr., *Norske Vidensk. Akad.*, Avh. I. Matem.-Naturv. Kl. No. 10 (1945).

Reduction of Tetrazolium Salt

SOME two hundred papers dealing with the chemistry of triphenyltetrazolium chloride and its use as a redox-indicator have been reviewed by Ried¹ and Smith². In spite of its wide use in biology, up to the present little is known about its reducing mechanism, the influence of experimental conditions on it, on its redox-potential, etc., and therefore the results obtained with it are empirical in character. Investigations of the salt by means of polarography and spectrophotometry carried out in this laboratory revealed some aspects which should be considered when using it as a chemical indicator of reducing power in biological reactions.

Polarographic study has shown that, in media of pH lower than 6, the reduction of triphenyltetrazolium chloride yields chiefly a colourless product:



In more alkaline solutions the reduction product is mainly the red formazan. This behaviour is due to the change of redox-potentials in the reduction of nitrogen atoms 1 and 2, and atoms 2 and 3 respectively (Fig. 1), and explains why reddening can be achieved only in solutions which are not too acid. The redox-

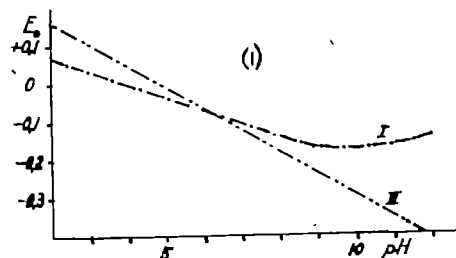


Fig. 1. Redox-potentials of triphenyltetrazolium chloride. Reduction of nitrogen atoms 2 and 3 (curve I) and of atoms 1 and 2 (curve II).

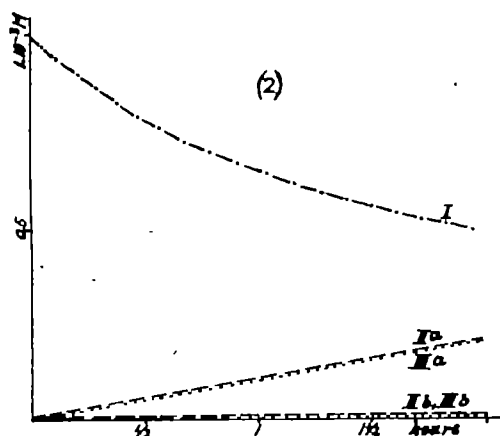


Fig. 2. Reaction-time curves of 10^{-3} M triphenyltetrazolium chloride

Curve I; disappearance of pure triphenyltetrazolium chloride in solution in light, neutral medium.

Curve II, a: formation of formazan, in the presence of 10^{-3} M ascorbic acid, pH 10.8, in light. Curve II, b: the same, in darkness. Curve III, a: formation of formazan in a diluted suspension of yeast (0.1 gm. $\rightarrow$ 10 ml), pH 7.5, in light. Curve III, b: the same, in darkness.

potential of formazan formation, contrary to other redox-indicators, cannot serve as a basis for predicting whether some reducing agent of known redox-potential will produce formazan or not. This is due to the insolubility of the reduced form of triphenyltetrazolium chloride: no redox-equilibrium can be established, and the actual potential of the substance will be therefore much more positive than its normal potential. This shows why triphenyltetrazolium chloride can be reduced by succino-dehydrogenase, which has a much more positive normal redox-potential.

Another important point to be considered is the influence of light on the enzymatic and non-enzymatic reduction of triphenyltetrazolium chloride. Fig. 2 shows that both types of reduction take place only in light; there is no reddening in darkness, except non-enzymatic reduction in strongly alkaline solution. Fig. 3 shows the influence of pH on both types of reduction, indicating clearly the basic difference between the two types of reactions. Fig. 2 shows also that triphenyltetrazolium chloride even in pure solution is converted by light into a 'photo-compound', which cannot be reduced to formazan. (The source

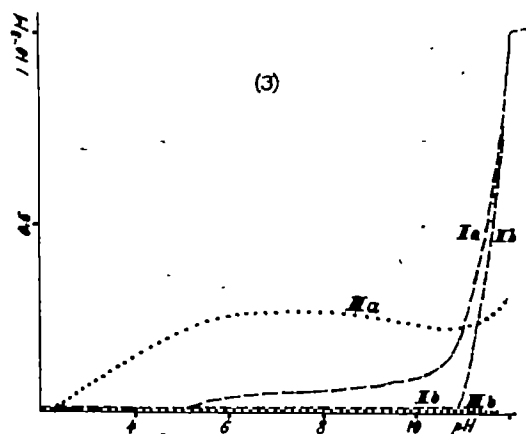


Fig. 3. Influence of pH on the formation of formazan in 10^{-3} M triphenyltetrazolium chloride, solution allowed to stand 2 hr with ascorbic acid (yeast). Details as in Fig. 2

of light in these experiments was the scattered light of the blue sky, of about 2,500 lux.)

Formazan is decomposed photochemically, as shown by Kuhn and co-workers². According to our experiments, this is an autocatalytic reaction, with the 'photo-compound' as catalyst. Hydrogen peroxide is formed as a by-product.

An interesting factor causing complications is further that triphenyltetrazolium chloride is converted into formazan in strongly alkaline medium spontaneously without the action of light or any reducing agent.

These results show clearly that the conditions must be carefully controlled when triphenyltetrazolium chloride is used for quantitative experiments.

Further details of this investigation will be published elsewhere⁴. I am indebted to Arapahoe Chemicals, Inc., Farbenfabriken Bayer and Lewis Laboratories, Inc., for supplying the triphenyltetrazolium chloride.

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¹ Ried, W., *Angew. Chem.*, **64**, 391 (1952).

² Smith, F. H., *Science*, **118**, 751 (1951).

³ Hauser, J., Jerschel, D., and Kuhn, R., *Chem. Ber.*, **83**, 195 (1949).

⁴ Jámor, B., *Acta. Chim. Acad. Sci. Hung.* (in the press).

Leucofuchsin in Algal Cytology

Astbury and Sana, in an article in *Nature*¹, state that there is some correspondence between the X-ray diagram of *Polytoma* flagella and that of certain polysaccharides; but no chemical confirmation of the presence of this type of compound could be found.

The diversity in structure of various algal flagella cautions against generalization. While the electron-micrograph given by Astbury and Sana represents *Euglena*, the X-ray diagram refers to *Polytoma*. These organisms are not closely related, if at all, and have different flagellar structures. In *Euglena*, the main stem of the flagella is covered with appendages which, in their dimensions and physical properties, recall bacterial flagella, although their function and behaviour are unknown.

In *Polytoma*, the delicate distal part of the flagella has approximately the same width as the appendages of the Eugleninean flagellum though it is stiffer, while the basal part is almost as thick as the flagellum of *Euglena*. There are still more differences in flagellar structure between the phyla of flagellates, which have to be kept in mind when investigating the physical and chemical nature of algal flagella.

By accident I came across a reaction which might be of help in such studies. In an attempt to learn something about the composition of paramylon, the peculiar reserve substance of the Euglenineae, which is chemically and physically similar to starch, the leucofuchsin technique, as used for demonstrating polysaccharides in histology², was employed; in this method, after oxidation with periodic acid, the cells are treated with Schiff's reagent (leucofuchsin). The result is that, unlike starch, paramylon is not stained.

All the flagella tested, comprising those of *Euglena*, *Eutreptia*, *Phacus*, *Cyclidiopsis*, *Polytoma*, *Chlamydomonas*, *Gonium*, *Ochromonas* and *Cryptomonas*, gave a positive reaction and became red in every instance,

those of the first four most distinctly, probably because they belong to the Euglenineae, which have wider flagella than the rest. Pre-treatment with saliva and washing with fat-solvents made no difference.

This positive reaction supports the view that there is, apart from proteins, also a polysaccharide component in all these flagella. The polysaccharide may have something to do with the marked elasticity of algal flagella and their defined way of beating, characteristics which are lacking in bacterial flagella and in the appendages of the Eugleninean flagellum, to judge by their shapes in electron-micrographs. The flagella of bacteria do not contain polysaccharides, so far as we know. The cilia of *Paramecium caudatum*, which are much shorter than flagella, do not seem to need elastic stiffening and give no leucofuchsin reaction.

A positive Schiff's reaction, however, was obtained after oxidation with periodic acid in the chlorophyll-containing chromatophores of all the organisms tested: Volvocales, Cryptophyceae, Euglenineae, Peridineae and Chlorophyceae, while without previous periodic-acid treatment no staining took place.

Apart from the Feulgen reaction, Schiff's reagent has previously been used for staining cell-walls of Algae. Prät² found that those of Heterococcales became purple-red with this reagent, in contrast to the cell-walls of Chlorophyceae. I can confirm his result.

After treatment with periodic acid, a positive result with Schiff's reagent is given by cell-walls of Cyanophyceae, *Spirogyra* and some Volvocales. A few Chlorophyceae tested were negative.

It may be mentioned that the leucofuchsin solution should be nearly colourless, or only pale yellow, but must not show the faintest tinge of pink, as traces of the unreduced fuchsin have a strong staining power.

I thank Dr. H. B. Fell for laboratory accommodation and the New York Zoological Society for a grant.

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¹ *Nature*, 171, 230 (1953).

² cf. Hotchkiss, R. D., *Arch. Biochem.*, 16, 131 (1948). Lillie, R. D., "Histopathologic Technique" (Philadelphia and Toronto 1948).

³ *Act. Soc. nat. Urus. Carro.*, 177 (1947)

Identity of Auxin in Normal Urine

THE aim of this work was to obtain auxin *a*, first isolated by Kogl, Haagen-Smit and Erxleben¹ from human urine in 1933. In their isolation procedure, these workers extracted a urine concentrate at an acid pH with ether. The ether extract in turn was partitioned into a neutral and an acid fraction with sodium bicarbonate. The auxin was present in the acid fraction and was subjected, in the final stages of the isolation procedure, to refluxing with methanol

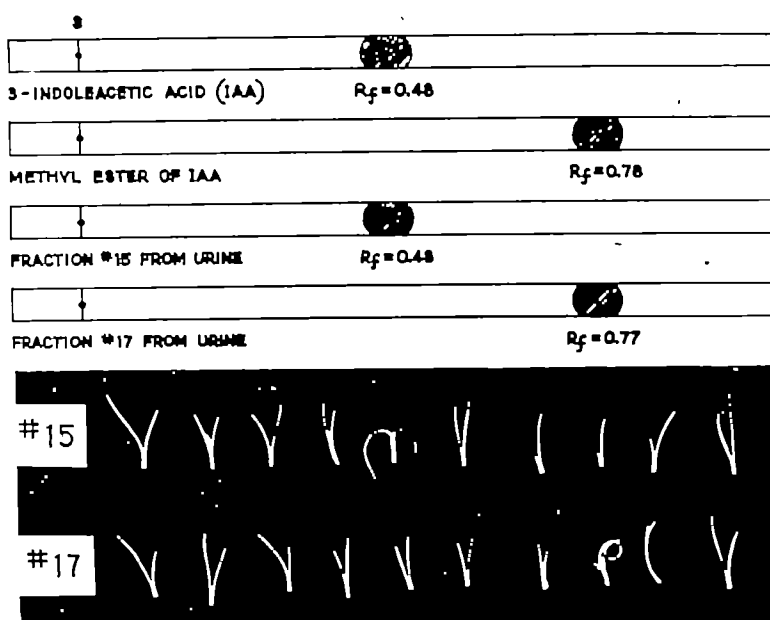


Fig. 1. Above: paper chromatograms of 3-indoleacetic acid and of its methyl ester compared with fractions 15 and 17 from urine. Below: biological activity of ten equal segments of the paper strips (R_f 0-0.1, 0.1-0.2, etc.) by the split *Avena* coleoptile test

containing 1.5 per cent hydrochloric acid. This step was followed by high-vacuum distillation, yielding a crystalline material with high auxin activity which they called auxin *a*.

In the present work, the procedure of Kogl *et al.* has been followed throughout. The auxin activity of the fractions was determined not by the *Avena* curvature test but by the split coleoptile test of Thumann and Schneider², which will detect 0.1 mgm./litre of 3-indoleacetic acid. Two batches of 40 litres of urine were processed and from them, after treatment with methanolic hydrochloric acid and high-vacuum distillation, a pale yellow oil was obtained having an activity about ten times that of indoleacetic acid as estimated by the split *Avena* coleoptile test.

The high-vacuum distillate (fraction 17) and its precursor before esterification with methanolic hydrochloric acid (fraction 15) were both studied by paper chromatography using the solvent system isopropyl alcohol-water-ammonia, 80-15-5. Some of the strips were sprayed with ferric chloride in perchloric acid³, others were cut into ten equal segments, each segment being placed in a Petri dish with three split *Avena* coleoptiles. The location of the coloured spots on these strips and the distribution of biological activity is shown in Fig. 1.

Fraction 15 gave a pink spot identical in colour with that given by 3-indoleacetic acid of R_f value 0.48 (3-indoleacetic acid had R_f 0.48). Fraction 17 gave a purple spot (R_f 0.77) identical in colour with that given by the methyl ester of 3-indoleacetic acid (R_f 0.78), which was prepared both by refluxing 3-indoleacetic acid with methanolic hydrochloric acid and by treating a methanolic solution of 3-indoleacetic acid with diazomethane. From fraction 17 a crystalline picrate was obtained identical with an authentic sample of the picrate of the methyl ester of 3-indoleacetic acid.

As can be seen from Fig. 1, the auxin activity on the paper strips (shown by curvature of the split

halves of the *Avena* coleoptile) coincided exactly with the coloured spots. No other region on the strips had auxin activity and none of the other fractions was active. These findings are in agreement with those of Bennet-Clark *et al.*³, who were unable to detect any auxin other than 3-indoleacetic acid in paper chromatograms of an ether extract of urine.

When the isolation procedure of Kögl *et al.*⁴ was applied to a solution of 3-indoleacetic acid, it resulted in the isolation of the methyl ester of this substance. There appears to be no step in this isolation scheme which would eliminate 3-indoleacetic acid or separate it from auxin *a*. In their paper on the isolation of 'hetero-auxin', Kögl *et al.*⁴ state that it remains a "companion of auxin *a* for a long time" but that "the last traces of heteroauxin are destroyed by refluxing with methanol containing 1.5% HCl". In our work, however, no such destruction was observed, provided dry methanol and dry hydrogen chloride were employed.

These results lead to the following conclusions:

(1) Neither of the two 40-litre samples of urine processed contained any auxin except indoleacetic acid.

(2) Treatment of the active fraction with methanolic hydrochloric acid does not destroy the 'hetero-auxin' as suggested by Kögl *et al.*⁴ but converts it to the methyl ester. The auxin activity of this ester as estimated by the split *Avena* coleoptile test and by the split pea internode test was greater than that of 3-indoleacetic acid. Kögl and Kostermann⁵ found the methyl ester less active than the free acid when tested by the *Avena* curvature test.

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¹ Kögl, F., Haagen-Smit, A. J., and Ertleben, H., *Z. physiol. Chem.*, **214**, 241 (1933).

² Thimann, K. V., and Schneider, C. L., *Amer. J. Bot.*, **23**, 792 (1936).

³ Bennet-Clark, T. A., Tambiah, M. S., and Kefford, N. P., *Nature*, **180**, 452 (1952).

⁴ Kögl, F., Haagen-Smit, A. J., and Ertleben, H., *Z. physiol. Chem.*, **236**, 90 (1934).

⁵ Kögl, F., and Kostermann, D. G. F. R., *Z. physiol. Chem.*, **235**, 201 (1935).

Blood-sugar in Foetal and Neonatal Mammals

It is well known that glucose is not found in equal concentration in the water phase of the red cells and plasma from some species of adult mammals. Nevertheless, it is conventional and convenient to cite values for the glucose concentration in the whole blood, and in studies confined to man this practice is generally satisfactory. In comparative physiology there is less justification for this convention, because it is the plasma glucose concentration which has a more direct influence on the tissue-fluid glucose concentration and sugar-regulating mechanisms. The difference between whole-blood and plasma glucose concentration is frequently considerable, for when the red cell is seemingly devoid of glucose, the plasma glucose concentration is, on the average, about 1.5 times the blood glucose concentration.

The importance of estimating plasma glucose became obvious in this laboratory during a study of the glucose concentration gradient across the placenta of the guinea pig. The blood glucose con-

Maternal circulation		Foetal circulation	
Glucose mgm./100 ml.		Glucose mgm./100 ml.	
Blood	Plasma	Blood	Plasma
92	135	92	104
64	85	64	75
106	134	67	102
88	116	87	97
80	110	70	86
Mean 86	116	84	93

centration was sometimes virtually the same in the foetal and maternal circulations but, on estimating plasma glucose, a considerable concentration gradient existed towards the foetus as shown in the accompanying table.

Previously, Hitchcock¹ had reported peculiarities in the corpuscular/plasma distribution of glucose in the young lamb. His findings suggested that this ratio declined rapidly after birth. In addition, Andreen, Svedberg² had observed a high distribution-ratio for glucose in blood from young calves and a baby pig.

In view of the implications above, this phenomenon has been examined in a large number of animals of several species (horse, pig, ox, sheep, goat, guinea pig and rabbit).

Fresh blood was collected over dried heparin at about 2° C. and, after sampling, the remaining blood was centrifuged in cups packed with ice until sufficient plasma was exposed. Generally, all deproteinization (using barium hydroxide and zinc sulphate) was complete within about twenty minutes of obtaining the blood. Glycolysis has been shown to be negligible during the whole procedure. Corpuscular glucose was derived from a knowledge of blood and plasma glucose and the packed cell volume. It is assumed that this technique, which examines the red cell in its natural medium, does in fact measure the *in vivo* concentration of glucose. The methods for estimating sugar have been described in a previous publication³.

The following general observations have been made.

1. The distribution of glucose usually conforms to one of two conditions: (a) an approximately equal concentration of glucose in the water phase of the red cell and the plasma (assuming that the water contents are similar to those in man); (b) a low or zero concentration of glucose within the cell. These two states may represent the conditions of free permeability and impermeability; but, pending further investigations along these lines, they will be referred to here as 'state *a*' and 'state *b*'.

2. In most species examined, the foetal and immediately post-natal corpuscles are in state *a* and, during the neonatal period, they change gradually to state *b*. It is possible that there are only two types of corpuscle and that the first is slowly replaced by the second.

3. The period of life during which this red-cell change occurs can vary with species: the corpuscles in the new-born pig being in state *a*, while those of the foal at birth are already in state *b*. As the change has always been observed to be from *a* to *b*, it is assumed that *a* is more immature and that a physiological change in the reverse direction would never occur. The persistence of the *a* corpuscle throughout life in man may be a reflexion of the mode of evolution of this species.

4. The consistently higher concentration of glucose within the cell compared with that in the plasma, as described by Hitchcock for the foetal lamb, has not been seen in this work for any species at any age.

5. A further complication may result in animals where more than one sugar is present in the blood³, for preliminary results suggest that the corpuscular/plasma sugar distribution may be different for glucose and fructose.

From these results, it is clear that, in foetal and neonatal physiology, the term 'blood-sugar' should be used only in a strictly literal sense. Figures derived from blood-sugar estimations cannot be legitimately compared, either for different species or for different ages of one species, without allowing for the particular characteristics of the red cell in each sample.

I am indebted to Dr. R. Scarisbrick, who not only directed my attention to this problem, but suggested that it should be developed in this way.

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¹ Hitchcock, M. W. S., *J. Physiol.*, 108, 117 (1949).

² Andreen-Svedberg, A., *Scand. Arch. Physiol.*, 66, 118 (1933).

³ Goodwin, R. F. W., *Nature*, 170, 760 (1952).

Resistance to the Maize Rust, *Puccinia polysora*

DURING 1953 we have studied resistance in maize to the form of the rust fungus, *Puccinia polysora* Underw., that recently appeared in East Africa¹. Our results augment the information given by Stanton and Cammack².

In our glasshouses at Muguga, Kenya, inoculation of young maize seedlings with fresh uredospores regularly caused infection, once technique was perfected. In a susceptible maize, uredosori were strongly developed about fourteen days after inoculation (Fig. 1). There was some variation between plants in the size and frequency of the sori and in the extent of the chlorosis surrounding them. Some plants, however, gave a distinct reaction, readily distinguished from any variant of the preceding reaction, the inoculated leaves showing only discrete, nearly circular necrotic areas, in which no sori developed or minute sori with limited spore-production (Fig. 2). This resistant reaction resembles the hypersensitive reaction well known with the rusts of wheat; it conforms with the description of Stanton and Cammack's "Stage 1"². A few plants, selected as seedlings, were grown to maturity in a glasshouse and reinoculated at intervals; their reaction at later stages of growth resembled that shown by them as seedlings.

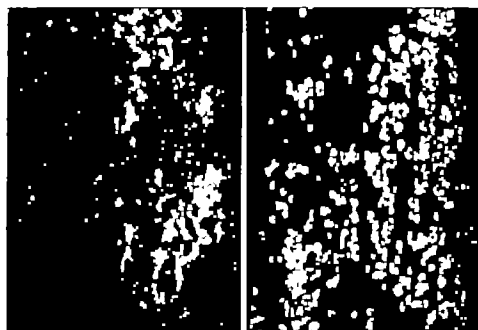


Fig. 1. *Puccinia polysora*. Susceptible reaction in maize leaf. Large spreading sori. ($\times 175$)

Fig. 2. *Puccinia polysora*. Resistant reaction in maize leaf. Necrotic areas with some small sori. ($\times 175$)

Table 1 SELFED PROGENIES

Parent		Family No.	Progeny tests	
Country of origin	Line No.		Plants resistant	Plants susceptible
Mexico	24	(1) (2)	9 0	5 4
	27	(1) (2)	13 0	7 5
Colombia	28	(1)	23	5
	29	(1)	16	3
	30	(1) (2)	6 20	2 4
	31	(1) (2)	7 7	7 3
	32	(1)	6	3
Totals			125	48
Expectation on 3:1 ratio			130	43

None of our material has given evidence of immunity from invasion by the fungus.

The resistant reaction was not found in any of forty-two maize varieties and lines received from sources in Africa. It was found in a few plants among collections originating in Mexico (received through Dr. W. Stanton) and in Colombia (Dr. L. M. Roberts, Agricultural Experiment Station, Medellin). Of twenty-five varieties and lines from these sources, fifteen gave only the susceptible reaction and the resistant plants were confined to the remaining ten.

Individual plants showing the resistant reaction were grown to maturity and selfed or crossed with susceptibles. Twelve progenies raised from selfed seed were tested. Of these, one gave forty-five plants all resistant in seven separate tests. The remaining eleven segregated into resistant and susceptibles as shown in Table 1.

Thirteen resistant plants were crossed with susceptibles; one gave twenty-eight plants all resistant (four tests) and the remainder segregated (Table 2).

The evidence indicates the presence of one major dominant gene for resistance. Differences in the responses that have been classed together as indicating susceptibility in the above progenies, and also in some progenies of North American origin, suggest the presence of at least one other gene with an effect

Table 2 CROSSED PROGENIES

Resistant parent		Family No.	Progeny tests	
Country of origin	Line No.		Plants resistant	Plants susceptible
Mexico	24	(1)	6	8
	27	(1) (2)	13 3	15 5
Colombia	28	(1)	11	10
	29	(1)	5	9
		(2)	8	4
		(3)	4	10
		(4)	10	4
	30	(1) (2) (3)	10 7 7	4 13 6
	31	(1)	9	17
Totals			93	105
Expectation on 1:1 ratio			99	99

large enough to be of possible value in breeding for resistance. We are continuing our studies of this possibility; meanwhile, our work is mainly concentrated on establishing maize stocks homozygous for the major gene in the expectation that these will be of use to those breeding for *P. polysora* resistance.

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Jan. 6.

¹ Nairam, R. M., *Nature*, 171, 527 (1953).

² Stanton, W. B., and Cammack, R. H., *Nature*, 173, 505 (1953).

Seedling Resistance and Mature-Plant Susceptibility of Wheat to *Puccinia graminis* found in Kenya

BREEDING and selection of wheat in Kenya for resistance to black stem rust has been based on seedling resistance tests coupled with identity tests of rust forms from the field and the breeding cages. Owing to lack of facilities, mature-plant tests have not been undertaken.

Though seedling and mature-plant resistance has been demonstrated to be independent¹, it has been found in Kenya that, by selecting resistant seedling lines, mature-plant resistance until recently has always been obtained. Such was the success of the plant breeders that the value of Kenya wheats has been recognized in various parts of the world, and they have been used as parents in breeding programmes, for example, in Australia, India, Egypt, the United States and Canada. Several seedling-susceptible but mature-plant resistant lines may well have been discarded in this process, for it is known that some varieties develop a mature-plant resistance from about the fifth leaf stage². This character was used by E. S. McFadden when he produced Hope and H.44.24 by crossing Yaroslav Emmer and Marquis³.

This seedling resistance-mature-plant resistance has, however, not held throughout. Seedling resistance-mature-plant susceptibility has been found in the following Kenya lines: 184 and 318 and in D.C. x Ceres R.46. These wheats were seedling resistant to certain rust forms by which they were attacked in the field. Their seedling resistance to other rust forms has apparently been maintained. All selections of these lines do not exhibit this behaviour, but remain constant in their resistance or susceptibility.

It has recently been shown in the United States⁴ that lines involving Montana and some other parents behave in a like manner.

I wish to thank the Honorable Director of Agriculture, Kenya Colony, for permission to publish this preliminary communication.

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Parasit Canker: Selection of Resistant Stocks of Parsnip

THE account by A. P. Jones¹ in *Nature* on *Streptomyces scabies* (Thaxter) Waksman and Henrici as the probable cause of parsnip canker is a welcome addition to the literature on a problem which has defied solution by various investigators during the past forty years. Previous to the above work, a survey of the problem was made by us during the period 1946-49 at the request of the Horticultural Group of the Agricultural Improvement Council and the results were embodied in the report AIC/HG/20, a summary of which was published in *Agriculture*². That report claimed to be no more than a fresh examination of the problem; but, although the exact nature of the causal organism was not discovered, a good deal of information was obtained. During the investigation it was clear that although no commercial variety or strain of parsnip was worthy of being called resistant to canker, there were always individual roots which in badly affected fields remained free from the trouble. This point has been noted by previous workers³.

Consequently, while the examination was proceeding, a look-out was kept for roots which remained clean in areas where canker was abundant. Such roots were intended to form a foundation for the selection and breeding of canker-resistant stocks possessing characters suitable for commercial crop production such as those possessed, for example, by the variety called Evesham. This variety is yellow-fleshed, broad in the shoulder and short in the root (that is, peg-top in shape) and is much valued on heavy soils because it lifts easily where longer varieties break off. It is, however, rather prone to canker.

The first roots were selected at the end of the very bad canker year of 1948, after which, in the spring of 1949, it was difficult to find parsnip roots free from canker. With the assistance of National Agricultural Advisory Service advisers in different parts of the country specimens were gathered and forwarded to Wisley, and from them ten clean roots of suitable types were chosen. These were planted at Wisley for seed production. Seven survived and were seeded under large muslin bags, and the seed was sown in February 1950 in heavy land where canker usually occurs. As the main investigation had shown that canker infection increases after October in any year, it was decided to leave the roots until late spring before lifting for examination.

The seven stocks sown in February 1950 were lifted in March 1951. In no case was canker severe, and two stocks (Nos. 4 and 5) were completely clean and of a good type. From them seven good roots were selected and replanted, protected with muslin, and seed harvested from each in the autumn. This was sown on the same land in February 1952 and the crop was lifted on March 10, 1953, when canker infection in six of the stocks varied from 0 to 11 per cent. The seventh stock, of which the seed had been badly discoloured, gave 34 per cent cankered roots. These roots were very large, their average weight being 50 per cent more than that of roots in the next heaviest stock, and this point may have some connexion with their susceptibility to canker. The fact remains that, in this trial as in previous ones, although canker was present in some stocks, there were others free or practically free from the trouble. The work to date indicates that resistance to canker

¹ Haynes, H. K., Stakman, H. C., and Aamodt, O. S., *Phytopath.*, 18, 371 (1925).

² Craigie, J. H., Dept. of Agric. (Canada) Pub. 606 (1940).

³ Campos, T., Gihler, J. W., and Boriang, N. B., *Phytopath.*, 43, 468 (abt) (1953).

exists in certain stocks from which it may be possible to select or breed varieties combining the resistance with acceptable commercial characters.

During the latter part of the work we have been in touch with the staff of the National Vegetable Research Station, and we are indebted to them for much interest in the parsnip trials. As part of their work will deal with parsnip canker, it was decided to offer them any material in which they were interested and this offer was accepted. Accordingly, at the lifting in March 1953 roots from each of our seven stocks of parsnips were sent to Wellesbourne for seeding there and in the hope that they will be of some value in any further research on canker. This communication is written to explain the origin and history of the stocks from the spring of 1949 onwards.

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Royal Horticultural Society's Gardens,
Wisley, Ripley,
Woking. Jan. 28.

¹ Jones, A. P., *Nature*, 171, 574 (1953).

² Green, D. E., and Hewlett, M. A., *Agriculture*, 57, 216 (1950).

³ Stripp, H. H., and Roebuck, A., *J. Agr. Sci.*, 33, 234 (1926-27)

Factors Influencing the Emergence of *Heterodera rostochiensis* Larvae

MANY investigators have reported a considerable variation in the seasonal rate of hatching of eggs from the cysts of *Heterodera rostochiensis*, in the presence of root diffusate.

Both Fenwick¹ and Lownsbury² have shown that the direct effect of temperature on cysts *in vitro*, in the presence of root diffusate, caused an increase in the amount of hatching with rise in temperature. They found the optimum rate of hatch was between 21° and 25° C., and both reported inhibition of hatching or dormancy at temperatures of 30°-33° C.

Recent investigations in this laboratory indicate, however, that seasonal variations in hatching are not simply the result of a direct correlation between temperature and hatching. It has been shown that the rate and amount of hatching from viable cysts of the same age maintained at 15° C. is profoundly influenced by the maximum temperatures to which the moist cysts have been subjected previously, before the addition of root diffusate. Except for a very brief note in a paper by Calam, Raistrick and Todd³, there appears to be no record of this indirect effect of temperature on moist cysts.

Samples of cysts of the same age were kept in water at temperatures of 15°, 23° and 29° C. for 34 days, and afterwards at 15° C. Two days later root diffusate was added to all samples. Four days afterwards, the cysts which had been pre-heated at 23° C. produced a hatch twenty to thirty times as great as the hatch from the cysts kept at 15° C., while none hatched from the cysts pre-heated at 29° C. All attempts to hatch eelworms from samples of cysts which had been kept at 29° C., by the addition of root diffusate, failed until twenty days after removing to the lower temperature of 15° C. The hatch was then very rapid and somewhat similar to that from cysts pre-heated at 23° C. Small amounts of hatching also occurred after the twentieth day in control batches of cysts pre-heated at 29° C. and to which no root diffusate had been added, in numbers similar to the emergence from cysts kept at 15° C.

These hatching results may explain the unexpected tomato and potato crop failures which occasionally occur at moderate viable cyst population levels, and would seem to explain the absence of winter dormancy reported by Fenwick¹ and the winter dormancy noted by Lownsbury² in the United States, where according to him the mean soil temperature of 6 in. depth averaged 22° C. during the summer.

This work is being continued and these results will be reported more fully elsewhere.

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¹ Fenwick, D. W., *J. Helminth.*, 25 (1/3), 37 (1951).

² Lownsbury, B. F., *Phytopath.*, 41 (10), 889 (1951).

³ Calam, G. T., Raistrick, H., and Todd, A. R., *Biochem. J.*, 45, 513 (1949).

⁴ Fenwick, D. W., *Nature*, 171, 47 (1953).

Effect of Oxygen on the Fixation of Nitrogen by *Azotobacter*

RECENT studies on the fixation of molecular nitrogen by both anaerobic¹ and aerobic² heterotrophic nitrogen-fixing bacteria indicate that ammonia is the first stable compound formed. This raises the question whether the necessary hydrogen is derived from water or from the metabolite. The latter source seems the more likely, especially since the union of metabolic hydrogen and molecular nitrogen to form ammonia could yield a considerable amount of free energy. If this were so, members of the anaerobic genus *Clostridium* would be expected to fix nitrogen more efficiently than the aerobic *Azotobacter*, which passes its metabolic hydrogen to oxygen. Results obtained in this laboratory show that *Clostridium* is, in fact, capable of more efficient nitrogen fixation than *Azotobacter*³. Again, if metabolic hydrogen is involved in the reduction of molecular nitrogen then, with a nitrogen-fixing aerobe, oxygen must compete with nitrogen for this hydrogen and so depress fixation. Conflicting results have been reported for the effect of partial pressure of oxygen on nitrogen fixation by *Azotobacter*⁴.

The effect of oxygen upon nitrogen fixation was examined in this laboratory using one strain of *Azotobacter vinelandii* and one of *Azotobacter chroococcum*. Both were slow-growing strains, and were grown in shallow liquid layers to allow ready diffusion of gases into and out of solution. The medium was a 1 per cent sucrose salts solution at pH 7, and contained yeast extract. 10-ml. aliquots were poured into 10-cm. Petri dishes, inoculated and incubated at 28° C. in sealed jars with different partial pressures of oxygen. The atmospheres in the jars were renewed frequently until the cultures were harvested after 21 days. Inoculated controls were acidified, stored and analysed with the cultures by micro-Kjeldahl method. At 4 per cent oxygen, *A. vinelandii* fixed 23.5 mgm. nitrogen, and *A. chroococcum* 21.6 mgm. nitrogen, per gm. sucrose supplied; at 20 per cent oxygen the fixation was 8.1 mgm. and 7.4 mgm. nitrogen respectively. These results showed greatly increased nitrogen-fixing efficiency with decreased partial pressures of oxygen (significant at the 0.1 per cent level).

When considered with the reported inhibition of nitrogen fixation by molecular hydrogen⁵, the inhibition by oxygen suggests that it is dehydrogenase hydrogen which is passed to nitrogen. Thus nitrogen

fixation might well be a form of respiration with nitrogen acting as an alternative to oxygen as a terminal hydrogen acceptor.

The bacteriological and agronomic implications of this theory will be discussed elsewhere, and further observations presented.

My thanks are due to the Rural Credits Development Fund of the Commonwealth Bank of Australia for financial assistance, and to Dr. R. J. Swaby, of the Division of Soils, Commonwealth Scientific and Industrial Research Organization, Waite Institute, Adelaide, for the culture of *Asotobacter vinelandii*.

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Dec. 1.

¹ Zelitch, I., Rosenblum, R. D., Burris, R. H., and Wilson, P. W., *J. Bact.*, **63**, 747 (1951).

² Newton, J. W., Wilson, P. W., and Burris, R. H., *J. Biol. Chem.*, **204**, 445 (1953).

³ Parker, O. A., *Aust. J. Agric. Res.* (in the press).

⁴ Burk, D., *J. Phys. Chem.*, **54**, 1195 (1950). Effe, J. M., *J. Agric. Res.*, **63**, 431 (1945).

⁵ Weckman, O. W., and Wilson, P. W., "Bacterial Physiology", 478 (Academic Press, Inc., N.Y., 1951).

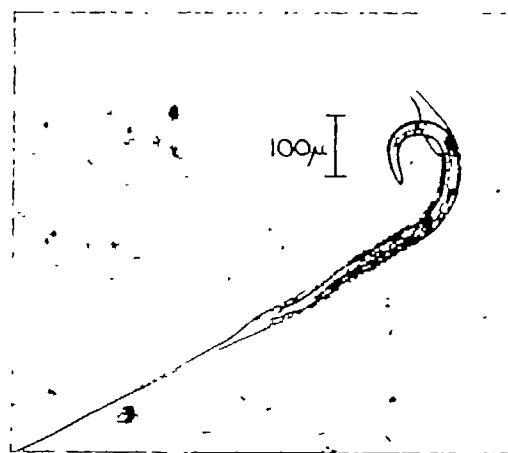
Second Ecdysis of Infective Nematode Larvae Parasitic in the Horse

THIRD-STAGE infective nematode larvae retain the sheath of the previous stage and, upon ingestion by the host, this is shed to liberate the enclosed individual. Lapege¹ showed that 'Milton' could induce an artificial ecdysis in the third-stage infective nematode larvae of sheep. Glaser and Stoll^{2,3} have reported successful results using a similar 'Labarraque' solution. Lapege⁴ induced ecdysis in a mixture of hydrochloric acid and sodium hydroxide at pH 9-10 and, apart from the time taken (8-10 days), the process seemed normal. Crofton⁵ studied the second ecdysis of *Trichostrongylus retortaeformis* (Zeder) and found that it could be initiated by pepsin and hydrochloric acid at pH 4-5, 60 hr. being required for exsheathment to occur. Stoll⁶ investigated the ecdysis of the first parasitic stage of *Haemonchus contortus* (Rudolphi) and reported that it occurred in hypotonic Ringer or Tyrode solutions, the addition of aqueous liver extract being highly beneficial.

Experiments conducted here with hydrochloric acid and sodium hydroxide both alone and in combination to give pH 8.5 have repeatedly failed to induce ecdysis in the third-stage infective larvae of the following equine nematodes: *Strongylus vulgaris* (Looss), *S. edentatus* (Looss), *Triodontophorus* spp., *Trichonema* spp., *Oesophagodontus robustus* (Giles) and *Trichostrongylus axei* (Cobbold). A temperature of 38° C. was maintained in all the experiments.

Successful ecdysis of the above species has, however, been repeatedly induced by utilizing muslin-filtered duodenal contents from freshly killed horses. The quickest time yet recorded for 100 per cent ecdysis is 1½ hr. in duodenal contents diluted with an equal volume of distilled water—the whole being kept at 38° C. Experiments with varying dilutions of duodenal contents have shown that the rate of ecdysis is directly proportional to the concentration.

Two distinct methods of ecdysis have been seen. The first is by detachment of a cap at the anterior end of the sheath as reported by Lapege⁴ for *Haemonchus contortus*, *Ostertagia circumcincta* (Stadelmann) and *Trichostrongylus* spp. after 8-10 days, and by Crofton⁵ for *Trichostrongylus retortaeformis* after



Third-stage larva of *Trichonema* sp. undergoing ecdysis by means of a split in the oesophageal region. (Photo. by O. Hughes)

60 hr. A similar process occurred in *Strongylus vulgaris*, *S. edentatus* and *Trichostrongylus axei* and was seen in some cases 60 min. after the addition of duodenal contents. The second method, which was observed in *Trichonema* spp., *Triodontophorus* spp. and *Oesophagodontus robustus* to occur equally quickly, does not involve the shedding of a cap. Larvae of these species develop a bulge at the anterior end in the region of the oesophagus, lashing movements enlarge this and eventually it ruptures to produce a split through which the larva escapes. The accompanying figure shows a *Trichonema* sp. larva leaving its sheath by this means.

Further investigations now nearing completion show that normal ecdysis may be induced by boiled duodenal contents, pig or horse bile and sodium taurocholate. No ecdysis occurred in sodium glycocholate or taurine. The complete results of these experiments will be published in the near future.

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¹ Lapege, G., *Nature*, **131**, 563 (1933).

² Glaser, R. W., and Stoll, N. R., *Science*, **87**, 250 (1938).

³ Glaser, R. W., and Stoll, N. R., *J. Parasitol.*, **36**, 87 (1940).

⁴ Lapege, G., *Parasitol.*, **37**, 185 (1935).

⁵ Crofton, H. D., *Parasitol.*, **33**, 101 (1947).

⁶ Stoll, N. R., *Growth*, **4**, 336 (1940).

Reproduction in Notostraca (Crustacea)

In some species of Notostraca, populations occur in which no males are found and these have generally been considered to reproduce by parthenogenesis; the European *Triops* (= *Apus*) *canoniformis* (Bosc.) exhibits a geographical variation in the occurrence of males, which are less common, or absent, in the north of its range, so that the species has been supposed to show parthenogenesis in colder, bisexuality in warmer regions, in the same manner as *Trichoniscus* (Isopoda, Crustacea).¹

The account in the year 1889 by Bernard² of the discovery of testis lobes in the gonads of female *Triops canoniformis* has been overlooked by recent writers; but during systematic work, in which this genus is being investigated cytologically, I have found testis lobes in the gonads of all the specimens which were examined from so-called parthenogenetic races

of *T. cancriformis*. These lobes can readily be seen in sections, smears and whole mounts of the ovotestes.

No living males of *Triops cancriformis* are yet available, and in order to confirm the nature of the lobes in the ovotestis of the hermaphrodites, testes of male *Triops granarius* (Lucas) (syn. *T. numidicus* (Grube)) have been examined for comparison. In each species the spermatocytes in all stages and round, non-flagellate sperms were found to be identical.

It has been possible to obtain evidence from chromosome numbers to show that the sperms produced in the ovotestis are functional. In *Triops cancriformis* both oocyte and spermatocyte nuclei have a haploid number of four chromosomes, while dividing cells of the follicle epithelium show that the diploid number of the species is eight. Precisely similar chromosome numbers occur in the same cells of bisexual *T. granarius*, in which cross-fertilization takes place. The hermaphrodites appear to be self-fertilizing, for pairing does not occur and sperms are present in the oviducts and follicle ducts throughout adult life.

Hermaphrodites are able to lay viable eggs in the absence of males, a fact long known for the so-called parthenogenetic races of *Triops cancriformis*, and it has now been possible to confirm this with *Triops longicaudatus* (Le Conte) from a Californian rice-field population consisting entirely of 'females', which lay viable eggs into their brood-pouches in the absence of males. Their gonads proved to be ovotestes, similar to those of *T. cancriformis*.

In other species bisexuality appears to be invariable, for in examining many samples of *Triops granarius* from Africa and Asia, I have found no instance where a large number of females without males might indicate hermaphroditism. The ovaries of this species were found to contain no testis lobes, a fact correlated with the inability of the females to lay eggs in isolation, and confirmed abundantly with cultures from two South African localities. A single female of *Triops australiensis* (S. and H.) reared in isolation laid no eggs, thus fitting in with the account of Spencer³, who examined ovaries of this species shortly after Bernard's report and found no testis lobes.

The populations of *Triops cancriformis* present an interesting problem; in some parts of the range the species is hermaphrodite, in others males occur sporadically, while bisexuality appears to be normal in North Africa. Brauer⁴ showed that females from a central European population with sporadic occurrence of males were able to produce viable eggs in isolation, but they copulated normally when reared with males. I have not been able to obtain females from such a population to find out what mechanism enables them to produce viable eggs without mating. A female from a bisexual population from Algeria had no testis lobes in the ovaries, and it appears likely that the normally bisexual *T. cancriformis* reproduces in the same manner as *T. granarius*.

Bernard^{5,6} also described an ovotestis in *Lepidurus arcticus* (Pallas) and in *Lepidurus apus* (L.). Specimens which I have examined of the former species from Alaska have, as he described, testis lobes crowded at the posterior end of the gonad, but no further investigation of this genus has yet been possible.

Hermaphroditism appears to be rare in Crustacea⁷, having previously been known only in the Cirripedia, although in some Decapoda and some parasitic Isopoda a sex-change occurs during life.

Systematic and cytological work is being continued on *Triops* and will be described fully elsewhere when it is completed.

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Feb. 11.

¹ Vandel, A., *Bull. Biol.*, 74, 94 (1940).

² Bernard, H. M., *Nature*, 43, 343 (1889).

³ Spencer, W. B., "The Horn Expedition" (X), 234 (1896).

⁴ Brauer, F., *S.B. Abnd. Wiss. Wiss.*, 65, 279 (1872).

⁵ Bernard, H. M., *Jour. S. Nature*, 35, 337 (1891).

⁶ Zimmer, G., in Kükenthal, W., "Handbuch der Zoologie", 3, (1), 295 (Berlin, 1926).

Iron Excretion by *Daphnia* during Hæmoglobin Loss

Daphnia contains hæmoglobin in solution in the blood. The concentration of the hæmoglobin is variable and depends upon the quantity of oxygen dissolved in the outside water: the less oxygen, the redder is the blood¹. I have made a histological study of the distribution of iron in the tissues of *Daphnia magna* Straus when gaining or losing hæmoglobin in response to a changed oxygen content of the water, and have found that when hæmoglobin is being lost from the blood, inorganic iron accumulates in the excretory organs.

The paired maxillary glands, or shell glands, of *Daphnia* are the excretory organs. Each consists of a closed internal oolomic end-sac, the sacculle, a long winding tube, the labyrinth, and a terminal loop, the vesicle, opening to the exterior². These shell glands lie in the hæmocoel and so are bathed by circulating blood. The presence of inorganic iron was shown by Bunting's modification³ of the Prussian blue histochemical technique. This does not reveal the iron in hæmoglobin.

Iron was found in the shell glands only at the time when the hæmoglobin concentration in the blood was decreasing, which suggests that the iron is derived from the breakdown of hæmoglobin and that it is being excreted. The distribution of iron within the shell gland supports this view, for iron was found both in the walls and in the lumen of the middle section or labyrinth, but only in the lumen of the distal section or vesicle. No iron was found in the inner portion or sacculle. In the labyrinth walls the iron stains as blue granules, but in the lumen it stains as a diffuse blue coloration. It is thus apparent that iron is excreted from the walls into the lumen of the labyrinth and thence passes through the vesicle lumen out of the body.

At the same time as iron appears in the shell glands of *Daphnia* which is losing hæmoglobin, it is found in the walls of the paired anterior gut cæca and in the cells of the fat body. One cannot be certain that the iron in the gut cæca is being excreted, since, unlike the shell glands, the cæca also have iron when the blood is gaining hæmoglobin. But more iron is present in the cæca of animals when losing hæmoglobin than at other times, which points to excretion. In the fat body, too, there is most iron when *Daphnia* is losing hæmoglobin, and this suggests that here is a site of hæmoglobin breakdown, with the liberation of iron to be excreted by the shell glands and perhaps by the gut cæca.

The expulsion from the body of iron derived from hæmoglobin breakdown is in direct contrast to the state of affairs in mammals, where the iron from the

continuous destruction of red blood cells is conserved and used again for further haemoglobin synthesis. In some mammals the iron derived from haemoglobin breakdown is temporarily stored as ferritin⁴, an iron-protein complex found in liver, spleen and bone marrow. I have been unable to obtain crystals of ferritin from *Daphnia* with the aid of cadmium sulphate, but it must be remembered that no ferritin has been found in oxen, sheep or deer.

Another striking difference between *Daphnia* and vertebrate animals is that in the latter, which continuously break down the haemoglobin of old red blood corpuscles, the haem portion of haemoglobin, after losing its iron, is excreted as bile pigment, whereas in *Daphnia* no bile pigment has been detected, either in extracts of large numbers of individuals⁵ or histologically. For the latter purpose I have used the method of Stein⁶. Since not only has no bile pigment been found in *Daphnia* losing haemoglobin, but also no porphyrin either⁷, it appears that the haem is broken down beyond the bile pigment or porphyrin stage to simpler colourless compounds.

The work reported here will be described in full elsewhere.

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Feb. 11.

¹ Fox, H. Munro, *Proc. Roy. Soc., B*, **135**, 195 (1948). Fox, H. Munro, and Phear, B. A., *ibid.*, **B**, **141**, 179 (1953).

² Glauco, C., *N. Wiss. Zool.*, **26**, 105 (1875).

³ Bunting, H., *Stain Techn.*, **24**, 100 (1949).

⁴ Granick, S., *Physiol. Rev.*, **31**, 430 (1951).

⁵ Fox, H. Munro (personal communication).

⁶ Stein, J., *C.R. Soc. Biol., Paris*, **130**, 1136 (1935).

'Mixed Layer' Minerals from the Ordovician Bentonite Beds at Kinnekulle, Sweden

In the course of an investigation of the bentonite beds in the Ordovician strata at Kinnekulle, Sweden, it became evident that the main part of these beds was composed of clay minerals belonging to the type of 'mixed layer' minerals that have random interstratification of illite and montmorillonite layers. The bentonite beds have been described in a paper by Waern *et al.*¹ by Thorslund, who also collected the materials used in this investigation partly from the two upper thin beds with a thickness of about 1 ft. each, and partly from the lower bentonite bed, which has a thickness of as much as 6 ft.

From chemical analyses, X-ray data, determinations of cation exchange capacities as well as from differential thermal analyses, and also from studies with the electron microscope, two different types of 'mixed layer' minerals have been distinguished. For one type, which is found mainly in the upper thin beds, the relation between illite and montmorillonite was found to be about 3:2. The K₂O content here was about 5 per cent. The other type constitutes the main part of the thick bed and has a much lower relation of illite to montmorillonite (about 1:4). The K₂O content in this case was about 2.5 per cent.

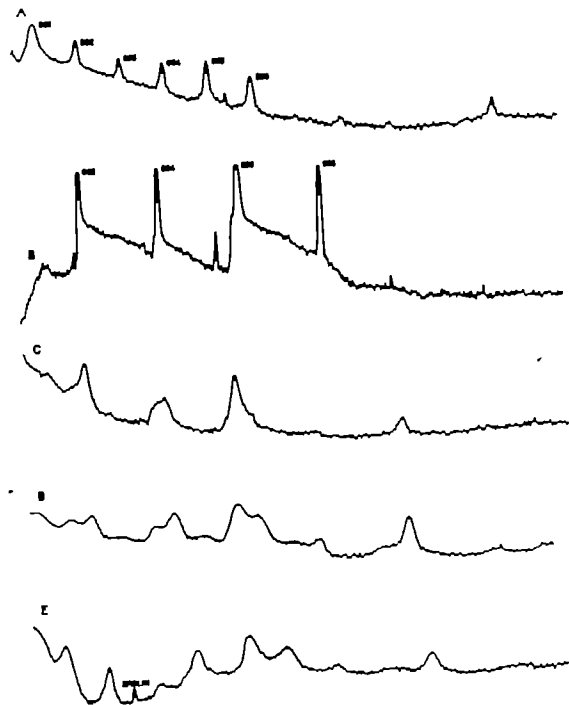
In Table 1 some data are collected for the two different types of 'mixed layer' minerals, and in the accompanying figure are microphotometer curves of some X-ray photographs of preparations, with layers oriented parallel to the basal planes. In this figure curves A, B and C are from pure minerals given here as a comparison, and curves D and E are

Table 1

	Type I Illite/montm. 1:4	Type II Illite/montm. 3:2
K ₂ O content	2.5 per cent	5 per cent
Cation exchange capacity	65 m.eqv./100 gm.	45 m.eqv./100 gm.
Low-order basal reflections of non-oriented preparations	at 13-14 kX. with glycerol { wet 17.8 kX. at 9.3 kX.	at 11.5 kX. { wet 18.9 kX. at 9.6 kX.
Endothermal reaction temp. from D.T.A.	570°-590° C. 880° C.	600°-625° C. 900°-920° C.
Dehydration temp.	120°-180° C. 425°-500° C.	120°-180° C. 450°-550° C.

from the material found at Kinnekulle. Actually, in curve D the double peaks are not so well resolved as could be expected from the photographic film, where the reflexions appear as two separate lines, although somewhat broad. From the curves we can see that the basal reflexions of the 'mixed layer' minerals are shifted in relation to those of montmorillonite and of illite, and that they can no longer be given rational indices that refer to cells of moderate size. This will also be seen from Table 2, where are listed intensities and spacings obtained from those preparations which gave curves D and E in the figure. The diagrams for random interstratification of layer minerals, given by Brown and MacEwan², have been used here to compute the ratio of illite layers to montmorillonite layers, and the values found from their curves are in agreement with those found in this investigation by other methods.

The material was very difficult to disperse in the media commonly used, and even after repeated



Microphotometer curves of X-ray reflections from glycerol-treated specimens, oriented parallel to the basal planes. A, sodium-montmorillonite; B, thin sheet of muscovite; C, illite, Torshult, Sweden; D, mixed layer mineral from Ordovician bentonites, Kinnekulle, Sweden, type II; E, mixed layer mineral from Ordovician bentonites, Kinnekulle, Sweden, type I.

Table 2. INTERSTICES AND SPACINGS FROM BASAL REFLECTIONS OF ORIENTED, GYRONOL-TREATED SPECIMENS OF BENTONITE MATERIAL FROM KINNEKULLE, SWEDEN

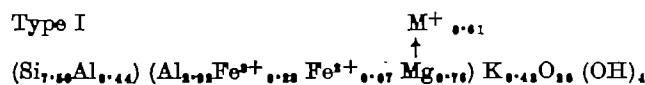
Type I		Type II	
I	d in Å.	I	d in Å.
wt	18.0	wt	18.1
st	9.0	wt	9.5
st	5.71	st	5.45
st	4.44	st	4.74
wt	3.43	wt	3.44
st	2.93	st	3.10
st	2.55	st	2.45
st	1.92	st	2.12
(st)	7.07	st	2.04

dispersions the sedimentary analyses showed all fractions to contain aggregates of the same type of clay minerals as found in the finest fractions. The material from the thick bed always showed a slight content of kaolinite (see figure, curve B), which was never found in the thin beds. The quartz content was very high in the thick bed and the fraction with particle size less than 2μ also contained some quartz. This mineral was also found in the thin beds, but in a much smaller amount.

The fact that only two distinct types of interstratification of montmorillonite and illite are found in the very abundant material from the bentonite beds at Kinnekulle, and not a complete series of transitions between the end-members, makes it appear probable that certain proportions are more stable than others. No doubt there are variations around the value of highest stability as the reflexions from the bentonite material are always broadened and somewhat diffused, as can be seen from the photometer curves. The proportion of highest stability seems to be connected with a repetition of five layers. In the material from Kinnekulle the ratios 1:4 and 3:2 were found, and earlier a mixed layer mineral of the same type was described by Weaver and Bates⁴, who found the ratio of illite layers to montmorillonite layers to be 4:1.

The material from Kinnekulle has also been compared with bravaissite, which was found by Bradley⁵ to consist of layers of montmorillonite and illite in random interstratification, and type II with the illite/montmorillonite ratio of 3:2 seems to be very nearly related to this mineral.

The following structure formulae are characteristic of each type:



M^+ denotes an exchangeable ion and is chiefly calcium or magnesium in the relation 4:1.

A more detailed report will be published in Sv. Geol. Unders. Årsbok, Ser. C.

ANN MARIE BYSTRÖM

Geological Survey of Sweden,
Stockholm 60. Dec. 3.

¹ Waern, B., Thornlund, P., and Henningsmoen, G., *Bull. Geol. Inst. Upsala*, 50, 337 (1948).

² Brown, G., and MacBryan, D. M. C., "X-Ray Identification and Structures of Clay Minerals", edit. Brindley, G. W., 200 (1950).

³ Weaver, C. H., and Bates, T. F., *Clay Min. Bull.*, 1, No. 8, 256 (1954).

⁴ Bradley, W. F., *Amer. Mineral.*, 50, 704 (1945).

Failure to Publish Scientific Results

PROF. P. A. BUXTON's letter in *Nature* of February 27, p. 410, complaining that the results of the aerial spraying experiments carried out in East Africa have not been made available is misleading and unfair to the workers concerned. Such experiments take nearly three years to complete because, although the air spraying may only occupy a matter of a few weeks, the assessment of the tsetse fly population before treatment, and more particularly after treatment, occupies a considerable time. Nine scientific papers have, however, been written up which deal fully with the work which has been carried out over the past six years. Four of these have already been published in addition to a communication in *Nature*¹⁻⁴, and the remaining five will appear during the present year.

In addition to the papers referred to above, members of the Colonial Insecticides Research Units have published ten scientific papers on other aspects of insecticide work during the past six years, and further papers are following. It is therefore a little unkind of Prof. Buxton to imply that these officers have omitted to write proper papers and have contented themselves with 'one-sided' progress reports. He appears to forget that the primary purpose of spending public money on Colonial research is a practical one, and that unless staff is unlimited the time occupied in the meticulous preparation required for a paper published in a scientific journal means delay in pressing on with the exploitation of preliminary results which can usefully be communicated to all the people most concerned with them by interim cyclostyled reports.

These interim reports have a wide circulation in the 'open' section of *Insecticide Abstracts*. There can be few people actively engaged in research on aerial insecticide treatment of insects who are not fully in touch with the progress of the work being carried out by the Colonial Insecticides Research Units, and none need be so ignorant of it that they are driven to use "other people's work". Although one endeavours to give the fullest references when writing up original work, it is not impossible, when one knows of the existence of work, to refer to it as 'in the press' or 'private communication', whichever is appropriate.

It would be difficult to give accurate figures for the cost of the air-spraying experiments, but it is common knowledge that the work with aircraft is costly. That it has been worth while is shown from the recent work⁵ at Maruzi, Uganda, where, in a sixteen square mile area of bush, a kill of more than 99.95 per cent of tsetse fly has been achieved by spraying from aircraft at a cost of approximately £1,000 per square mile.

W. J. HALL

(Chairman,

Colonial Insecticides Committee)

Commonwealth Institute of Entomology,
o/o British Museum (Natural History),
• Cromwell Road,
London, S.W.7.

¹ Hooking and Yeo, *Bull. Ent. Res.*, 44, 589 (1953).

² Hooking, Parr, Yeo and Robins, *Bull. Ent. Res.*, 44, 601 (1953).

³ Thompson, *Bull. Ent. Res.*, 44, 611 (1953).

⁴ Hooking, Parr, Yeo and Ansley, *Bull. Ent. Res.*, 44, 627 (1953).

⁵ *Nature*, 173, 168 (1953).

⁶ Private communication.

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, April 26

ROYAL SOCIETY OF EDINBURGH (at 24 George Street, Edinburgh), at 4.30 p.m.—Lectures under the Terms of the Robert Cormack Bequest. Mr. A. B. Roy: "The Occurrence of Commensurabilities in the Mean Motions of Planets and Satellites"; Dr. M. J. Smyth: "Photoelectric Investigations of Solar Corpuscular Radiation"; Dr. J. Omer, Mr. James Ring and Dr. W. L. Wilcock: "Dielectric Interference Filters and their Recent Applications in Astronomical Photography"; Mr. M. W. Orendan: "Photometric Effects of Gaseous Envelopes in Belping Binaries".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. W. S. Stiles: "Problems of Colour Vision".

INSTITUTION OF ELECTRICAL ENGINEERS, RADIO SECTION (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. W. Lawrence: Informal Lecture on "The Experimental Synthesis of Speech".

INSTITUTE OF METALS (at the Royal Institution, Albemarle Street, London, W.1), at 7 p.m.—Prof. L. F. Bates, F.R.S.: "The Domain Structure of Ferromagnetic Metals" (Annual May Lecture).

Monday, April 26—Saturday, May 1

INSTITUTE OF METALS (Joint meeting with the Société Française de Métallurgie, at Church House, Great Smith Street, London, S.W.1)—Spring Meeting.

Thursday, April 29

Informal Discussion on "Recovery and Recrystallization".

Tuesday, April 27

SOCIETY FOR ENDOCRINOLOGY (in the Barnes Hall, Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 5.15 p.m.—Dr. Gregory Pincus: "Pathways of Steroid Synthesis in the Animal Organism".

SOCIETY OF INSTRUMENT TECHNOLOGY (at Mason House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. S. L. Anderson: "Instruments for Testing and Control in the Textile Industry".

ROYAL AERONAUTICAL SOCIETY (in the Library, 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. G. H. Lee: "Aerodynamic and Aeroelastic Characteristics of the Crescent Wing".

BRITISH SOCIOLOGICAL ASSOCIATION (at the Royal Society of Arts, 6 John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Prof. Talcott Parsons (Harvard): "A Reconsideration of the Problem of Social Evolution".

Wednesday, April 28

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting.

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 6 p.m.—Annual General Meeting; Dr. O. G. Sutton, F.R.S.: "The Development of Meteorology as an Exact Science" (Presidential Address).

PRESENTATION OF TECHNICAL INFORMATION DISCUSSION GROUP (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 6 p.m.—Discussion on "The Techniques of Communication by Film". Chairman: Mr. K. Lockhart Smith.

INSTITUTION OF MECHANICAL ENGINEERS, EDUCATION GROUP (at 1 Birdcage Walk, Westminster, London, S.W.1), at 6.45 p.m.—Discussion on "The Mathematical Content of Engineering Courses".

Thursday, April 29

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.15 p.m.—Discussion on "The First and Second Viscosities of Fluids" opened by Prof. L. Rosenhead, F.R.S.

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Dr. D. T. A. Townsend: "The New Education Scheme of the Institute of Fuel".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, London, W.C.2), at 5.30 p.m.—Mr. J. A. Ratcliffe, F.R.S.: "The Physics of the Ionosphere". (The Forty-Fifth Kelvin Lecture).

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (in the Lecture Hall of the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Annual General Meeting. Mr. H. K. Purdie: "Control of Sound in Buildings—Requirements, Materials and Methods".

Friday, April 30

INSTITUTION OF CHEMICAL ENGINEERS (at the May Fair Hotel, Bedford Street, London, W.1), at 11 a.m.—Thirty-second Annual Corporate Meeting.

TECHNICAL INSTITUTE (at the Queen's University, Belfast), at 2.45 p.m.—Annual General Meeting. 2.45 p.m.—Dr. D. A. Gilbreath: "Cellulose Chemistry and the Textile Industry".

CHEMICAL SOCIETY (in the Chemistry Lecture Theatre, The University, Liverpool), at 5 p.m.—Dr. R. H. Manake: "The Story of the Isoquinoline Alkaloids" (Gomberg Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (at 1 Birdcage Walk, Westminster, London, S.W.1), at 5.30 p.m.—Mr. S. B. Bailey: "Nodular Cast Iron: Its Present Position and Future Prospects as an Engineering Material, with Special Reference to its Suitability for Crankshafts".

UNIVERSITY OF LONDON (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Dr. B. N. Jones: "Applications of Infra-Red Spectra to Organic Chemistry".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (at the National Institute for Medical Research, The Ridgeway, Mill Hill, London, N.W.7), at 7 p.m.—Dr. B. K. Callow: "Medical Research and Fine Chemicals".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. M. Postan: "Medieval Science and Technology".

Saturday, May 1

ASSOCIATION OF CHEMICAL BIOCHEMISTS, SOUTHERN REGION (at the Radcliffe Infirmary, Oxford), at 2 p.m.—Demonstrations and Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR LECTURER IN MATHEMATICS at the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 30).

ASSISTANT LECTURER IN GEOPHYSICS OR CYTOLOGY—The Registrar, The University, Sheffield (May 1).

LECTURER and an ASSISTANT LECTURER IN THE DEPARTMENT OF PURE MATHEMATICS—The Registrar, The University, Liverpool (May 1).

LECTURER IN EDUCATIONAL PSYCHOLOGY at the University of Natal, Durban, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, May 1).

LECTURER or ASSISTANT LECTURER (preferably with qualifications and experience in chemical engineering or a branch of chemical technology) IN THE DEPARTMENT OF CHEMISTRY, at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 1).

LECTURER (preferably with special qualifications in survey) IN GEOGRAPHY—The Secretary of University Court, The University, Glasgow (May 1).

SENIOR LECTURER and a LECTURER (with an honours degree, and preferably with teaching and industrial experience) IN THE DEPARTMENT OF CHEMISTRY—The Clerk to the Governing Body, College of Technology, Birmingham (May 1).

SENIOR LECTURER (with qualifications and experience necessary to plan and supervise the teaching of organic chemistry up to honours degree standard) IN ORGANIC CHEMISTRY—The Principal, Royal Technical College, Salford 5 (May 1).

UNIVERSITY LECTURER IN THE DEPARTMENT OF ANIMAL PATHOLOGY, to undertake teaching and research in veterinary parasitology—The Secretary, Appointments Committee of the Faculty of Biology "B", Department of Pathology, Tennis Court Road, Cambridge (May 1).

DEMONSTRATOR (honours graduate in chemistry or biochemistry) IN CHEMICAL PATHOLOGY—The Registrar, The University, Leeds 2 (May 3).

LECTURER or ASSISTANT LECTURER IN AERONAUTICAL ENGINEERING, a LECTURER IN ELECTRICAL ENGINEERING, an ASSISTANT LECTURER IN GEOLOGY, and an ASSISTANT LECTURER IN MATHEMATICS—The Registrar, Queen Mary College (University of London), Mile End Road, London, E.1 (May 3).

SENIOR SCIENTIFIC OFFICER (with first or second-class honours degree in chemistry or equivalent, and at least three years postgraduate research, and a thorough knowledge of the mass spectrometer and experience in its application) IN THE CHEMICAL RESEARCH LABORATORY, Department of Scientific and Industrial Research, Teddington—The Secretary, Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting 84314/54 (May 6).

HEAD OF THE DEPARTMENT OF GEOLOGY at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 7).

LECTURER IN MATHEMATICS at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 7).

LECTURER IN BACTERIOLOGY AND VIRUS DISEASE—The Registrar, The University, Sheffield (May 8).

ASSISTANT ENTOMOLOGIST (with at least a second-class honours degree in science, with entomology as a major subject) at the Wattle Research Institute, University of Natal, Pietermaritzburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, May 15).

LECTURER or ASSISTANT LECTURER (preferably with qualifications in nuclear physics and electronics) IN PHYSICS—The Secretary, University College of the South-West, Exeter (May 15).

ASSISTANT LECTURER IN ANATOMY, to undertake teaching and research—The Secretary, University College London, Gower Street, London, W.C.1 (May 21).

CHAIR OF APPLIED ELECTRICITY—The Secretary and Registrar, University College of North Wales, Bangor, N. Wales (May 24).

READER IN PURE MATHEMATICS at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 25).

ASSISTANT LECTURER IN GEOLOGY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (May 29).

CHAIR OF PHYSICAL OR INORGANIC CHEMISTRY—The Secretary, Queen's University, Belfast (May 31).

CHAIR OF PURE MATHEMATICS—The Secretary, The University, Birmingham 3 (May 31).

LECTURER IN PHYSICS at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 31).

BROTHERTON RESEARCH FELLOW IN PHYSICAL CHEMISTRY, and a RESEARCH ASSISTANT IN DYING, in the Department of Colour Chemistry and Dyeing—The Registrar, The University, Leeds 2 (June 1).

RESEARCH ASSISTANT IN MATHEMATICAL STATISTICS and a RESEARCH ASSISTANT IN NUMERICAL ANALYSIS, in the Department of Applied Mathematics—The Registrar, The University, Liverpool (June 1).

LECTURER (with a university degree, preferably in forestry, and practical experience of forestry in Great Britain or abroad) in **FORESTRY**—The Secretary, The University, Edinburgh (June 15).

DEMONSTRATOR (preferably with a degree and some ability in the experimental testing of rockets, ram jets, gas turbine combustion chambers, or other aspects of modern power plants) in **THE DEPARTMENT OF AIRCRAFT PROPULSION**—The Recorder, The College of Aeronautics, Cranfield, Bletchley, Bucks.

LECTURER (with a degree in horticulture or horticultural botany) in **HORTICULTURE**, in the Faculty of Agriculture, Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1.

METALLURGISTS, Experimental Officer grade (with at least H.S.C. in science subjects) in the Department of Atomic Energy, Harwell, near Preston, for development work up to pilot plant scale for the reduction or fabrication, including casting, mechanical working, welding and powder metallurgy, of unusual metals—The Department of Atomic Energy, Industrial Group Headquarters, Ruxley, Warrington, quoting 572.

PERRING SCHOLAR (preferably honours graduate or final year undergraduate in engineering, mathematics or physics) in **AERONAUTICS**—The Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks.

PHYSICISTS (with a good honours degree and some experience or training in research, not necessarily in textile research) to work on textile problems—The Secretary, British Rayon Research Association, Barton Dock Road, Urningston, near Manchester.

SCIENTIFIC ASSISTANT (with a university degree, and a knowledge of two or more European languages, and ability to write clear, concise English), for duties which include abstracting world scientific literature on animal breeding, genetics and production—The Director, Commonwealth Bureau of Animal Breeding and Genetics, King's Buildings, Edinburgh 8.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or engineering, or equivalent qualifications, and at least three years postgraduate research experience) to supervise and participate in the activities of a group investigating the mechanical properties under stress (including tests to mechanical destruction) of prototype atomic weapons—The Administrative Officer, Recruitment Section, Atomic Weapons Research Establishment, Aldermaston, quoting 106/WGB/2.

SCIENTIFIC OFFICERS (3) (with first- or second-class honours degree in inorganic or physical chemistry, or equivalent qualifications), at the Water Pollution Research Laboratory, Department of Scientific and Industrial Research, Slough, to study the effects and treatment of pollution of rivers by waste waters containing inorganic and organic impurities—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting F.227/54A.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Parliamentary and Scientific Committee. (An unofficial group of Members of both Houses of Parliament, and representatives of certain scientific and technical institutions). Annual Report, 1953. Pp. 28. (London: Parliamentary and Scientific Committee, 1954.) [152]

Privy Council. Agricultural Research Council. Index of Agricultural Research in Progress during 1953-54. Pp. ix+118. (London: H.M. Stationery Office, 1954.) 5s. net. [152]

University of Leeds: The Brotherton Collection. The Eighteenth Annual Report of the Brotherton Collection Committee, Session 1953-54. Pp. 10. (Leeds: University of Leeds, 1954.) [152]

The Rowett Research Institute. Collected Papers with Summarized Account of Contents. Vol. 10. Pp. 24. (Buckaburn: Rowett Research Institute, 1954.) [152]

Careers in Agricultural Research. Training Grants, Studentships and Fellowships awarded by The Agricultural Research Council. Pp. 14. (London: Agricultural Research Council, 1954.) [152]

Department of Scientific and Industrial Research and Fire Offices' Committee. Fire Research, Special Report No. 2: Heat Transfer by Radiation. By J. H. McGuire. Pp. v+29. (London: H.M. Stationery Office, 1953.) 1s. 6d. [152]

Transactions of the Edinburgh Geological Society. Session 1953-54. Vol. 16, Part 1: Catalogue of Type and Figured Specimens of Fossil Fishes and Amphibians in the Royal Scottish Museum, Edinburgh. By Dr. Charles D. Watkinson. Pp. x+91. (Edinburgh and London: Oliver and Boyd, Ltd., 1954.) 7s. 6d. (to Fellows 6s.) [152]

National Museum of Wales. Forty-Sixth Annual Report, 1953-54. Pp. 63. (Cardiff: National Museum of Wales, 1953.) [152]

Annual Report of the National Oceanographic Council. 1 April 1953-31 March 1953. Pp. v+34+3 plates. (Cambridge: At the University Press, 1954.) 6s. net. [152]

Bulletin of the British Museum (Natural History). Historical Series, Vol. 1, No. 2: Louis Auguste Deshayes. By O. G. G. J. Van Steenis, M. J. Van Steenis-Krusman and A. Backer. Pp. 49-68+plate 13. 6s. Zoology. Vol. 2, No. 4: The Macrotrichopus Problem. By Dr. W. J. Roca. Pp. 67-100+plate 2. 12s. Vol. 2, No. 5: Hearing in Octopods. By F. C. Fraser and P. B. Purves. Pp. 101-114+plates 4 and 6. 4s. (London: British Museum (Natural History), 1953.) [152]

A Career in the Gas Industry. Pp. 24. (London: The Gas Council, 1954.) [152]

Current Iodine Literature. List No. 1, 1954. Pp. 13. (London: Chilean Iodine Educational Bureau, 1954.) [152]

British Museum (Natural History). The John Murray Expedition 1933-34. Scientific Reports. Vol. 10, No. 2: Scaphopoda. Pp. 91-120+1 plate. (London: British Museum (Natural History), 1954.) 7s. 6d. [152]

Scottish Home Department. Report of the Scottish Pest Committee. Pp. 66+8 plates. (London: H.M. Stationery Office, 1954.) 5s. net. [152]

Aero Research Technical Notes. Bulletin No. 133: Tropical Exposure Tests on "Aerolite" 800. Pp. 4. (Duxford: Aero Research, Ltd., 1954.) [152]

Scottish Home Department. Freshwater and Salmon Fisheries Research. No. 6: Fifth Annual Report of the Supervisory Committee for Brown Trout Research 1952-1953. Pp. 12. (Edinburgh: H.M. Stationery Office, 1954.) 2s. net. [152]

Other Countries

Yale Medical Library. Annual Report including the Report of the Historical Library, 1942-1953. Pp. 42. (New Haven, Conn.: Yale Medical Library, 1953.) [152]

Institut de France. Académie des Sciences. Annuaire pour 1954. Pp. 256. (Paris: Gauthier-Villars, 1954.) n.p. [152]

A Brief Description of the Timbers Included in the Malayan Grading Rules. By A. V. Thomas. Pp. ii+15. (Singapore: Government Printing Office, 1953.) 50 cents. [152]

United States Naval Observatory. Circular No. 46: Positions, Areas, and Counts of Sunspots, August-September-October, 1953. By Winifred Sawtell. Pp. 8. (Washington, D.C.: U.S. Naval Observatory, 1953.) [152]

Proceedings of the California Academy of Sciences. Fourth Series, Vol. 28, No. 4: Natural History of the Pallid Bat, *Amorocetus pallidus* (Le Conte). By Robert T. Orr. Pp. 166-246. (San Francisco: California Academy of Sciences, 1954.) [152]

Joint Establishment for Nuclear Energy Research. Second Annual Report, 1952/53. Pp. iv+41. (Blithers, Ohio: Akademik Trykingscentral, 1953.) [152]

Deutsche Akademie der Wissenschaften zu Berlin: Institut für Physikalische Hydrographie. Acta Hydrographica. Band 1, Heft 1, 1953. Pp. 56. (Berlin: Akademie Verlag, 1953.) [152]

Svenska Geologiska Undersökning. Ser. O. No. 518. Arsbok 44 (1950). No. 4: Vissa Ämnens Fördelning i Markens I Kopparbergs Län. Av O. Arrhenius. Pp. 40. (Stockholm: Kungl. Boktryckeriet, P. A. Norstedt och Söner, 1953.) 2.50 kronor. [152]

Tobacco Research Board of Southern Rhodesia. Report of Progress 1951-1953. (Bulwer's 3.) Pp. 48. (Kutlaga: Tobacco Research Board of Southern Rhodesia, 1953.) [152]

Publications de l'Institut National pour l'Etude Agronomique du Congo Belge. Flore du Congo Belge et du Ruanda-Urundi, préparée par le Comité exécutif de la Flore du Congo Belge et le Jardin Botanique de l'Etat. Spermatophytes—Vol. 4. Pp. vi+214. 800 francs. Serie Scientifique, No. 88: L'Alimentation Minérale du *Oenococcus Oenococcus* L. Etude publiée sous la direction de Prof. Marcel V. Hombe. Pp. 128. 125 francs. (Bruxelles: Institut National pour l'Etude Agronomique du Congo Belge, 1953.) [152]

Československá Akademie Věd. Publikace Astrofyzikálního Observatoria Ondřejov. No. 25: Katalog Mesíčních Vápníků 1890-1953. 1: Zvěstování Mesíčních 8tín. By F. Link and Z. Linková. Katalog Mesíčních Kráterů. By J. Bouška, F. Hrabík and Z. Švestka. Pp. 116. (Praha: Nakladatelství Československé Akademie Věd, 1953.) [152]

Ročník Astronomický. Obserwatorium Krakowskiego, 1954. (Nr. 25.) Dodatek Miedzynarodowy: Supplemente Internationale. Wydal T. Banachiewicz. Pp. ix+96. (Krakow: Obserwatorium Krakowskiego, 1954.) [152]

Mitteilungen des Deutschen Wetterdienstes. No. 6: Berechnung der Verdunstung aus klimatologischen Daten. Von Dr. Siegfried Uhlig. Pp. 24. (Bad Kissingen: Deutscher Wetterdienst, 1954.) [152]

Associations. (The Review of International Organizations and Meetings.) (Formerly "IGO Bulletin.") January, 1954. Pp. 64. (Bruxelles: Union of International Associations, 1954.) [152]

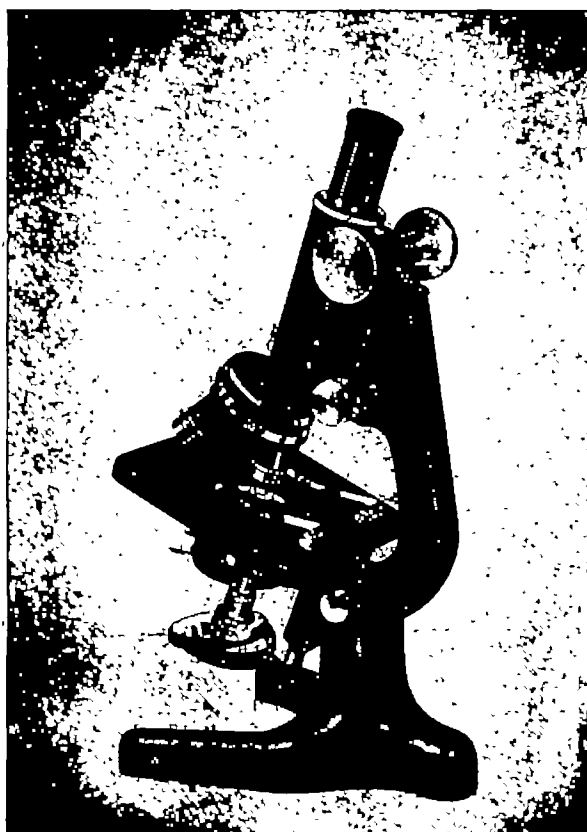
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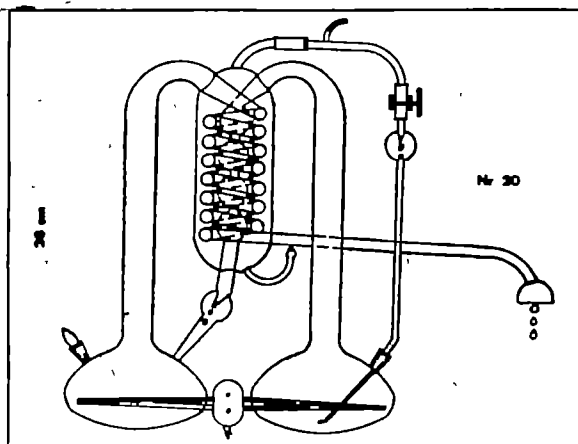
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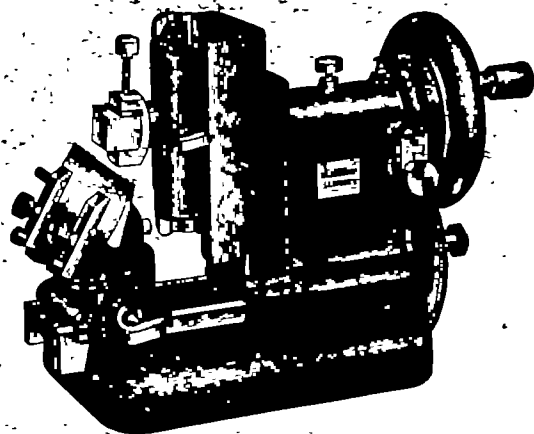
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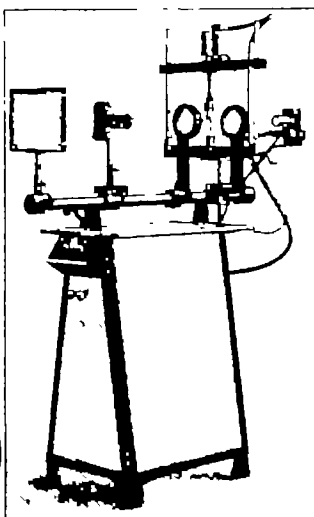
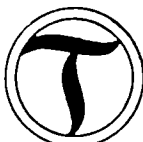
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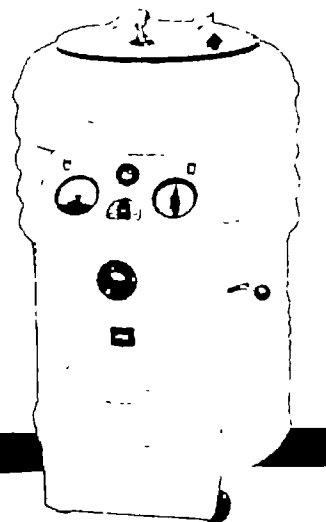
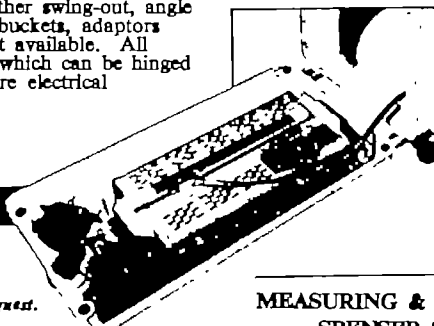
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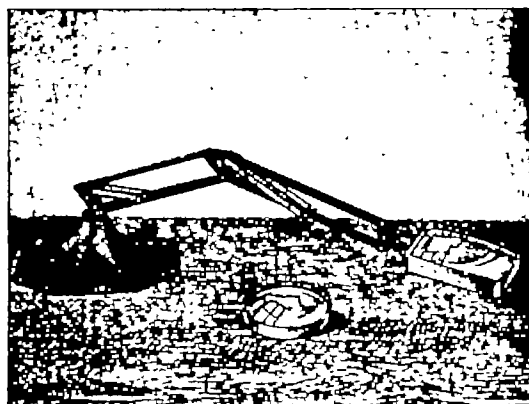


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SCIENTIFIC RESEARCH AND INDUSTRY IN BRITAIN

THE deepening anxiety which marked the two preceding reports of the Advisory Council for Scientific and Industrial Research is appreciably diminished in the report of the Advisory Council for 1952-53, a survey of which appears elsewhere in this issue (p. 797). Difficulties arising from the exiguity of current resources are again recorded, and it is once more apparent that the nation's economic development has been hindered by restrictions imposed upon the activities of the Department of Scientific and Industrial Research during recent years which retarded its plans for the development, for example, of the Hydraulics Research Station, the Water Pollution Research Laboratory, and the Mechanical Engineering Research Organization. The Advisory Council does not recapitulate these frustrations, nor does it pretend that the new arrangements for the five years beginning April 1, 1954, announced on November 27, 1953, will necessarily mean the end of all difficulties. The broad effect of those arrangements will be to bring the Department's post-war plans nearly to completion by 1959, thirteen years after they were originally approved in 1946. Further, the Advisory Council understands that it may now advise on the future activities of the Department on a basis essentially that for which it pressed in its report for 1950-51; the provision which allows it to carry over unspent balances from one year to another gives it the flexibility which it has repeatedly stressed and which had already received strong support in debates in Parliament.

None the less, the increase in expenditure proposed in the estimates for 1953-54 and for 1954-55 is not large, either in relation to the Department's net expenditure of £5.2 million in 1952-53, or to the national expenditure as a whole. Even in 1959, the net annual resources of the Department are only expected to exceed £6 million very slightly, whereas in 1951 the total expenditure on industrial research and development was estimated in a recent debate in the House of Commons as £268 million, of which probably about £70 million was on civilian research. A recent survey made by the Harvard Business School estimated that industry in the United States spent in that year 2,500 million dollars on research and planned to increase this to more than 3,000 million in 1953.

Thus, the fact that the Advisory Council considers that the new arrangements afford firm ground on which to advise how best to allocate the resources it expects to be available and on which to base forward policy with reasonable assurance that recommendations will not be stultified by lack of means for carrying them to fulfilment, cannot be taken to imply that the resources at the disposal of the Department are adequate for the discharge of the responsibilities which are appropriately laid upon it. On the contrary, the new arrangements make the more urgent and imperative a continuing review of the functions of the Department and the resources at its disposal in relation to the research organization

of Great Britain as a whole, and the resources available to meet the needs of scientific and industrial research and development in all the varied fields of defence, economic development and welfare. That need is well brought out in the present report, for the Advisory Council recognizes very clearly the dynamic character of some of the Department's activities, such as those of the National Physical Laboratory, with the consequent budding off of new sections from time to time. Such changes, moreover, need not necessarily be solely within the Department. They could equally lead to the shedding of responsibilities, as may well follow from one development specifically noted in the report—the formation of companies, analogous to the National Research Development Corporation, to which particular research associations can transfer their responsibilities for economic development of their inventions or discoveries.

In another field, the educational responsibilities of the research associations are assuming an importance, particularly in relation to technological education, which may well render desirable some assessment of the position of the research associations in relation to the expansion of higher technological education apart from their contribution to research, and consideration of the resources to be apportioned to that field. This aspect of the work of the research associations derives its importance at least in part from their place in furthering the more effective utilization of existing knowledge as distinct from the acquisition of new knowledge. Much stress has been laid in recent years on the value of the liaison work of the research associations in furthering the exploitation of science by industry. This work receives special emphasis in the current report, which directs particular attention to the work in this connexion of the Intelligence and Information Division in the headquarters office of the Department.

On the research side, the report brings out more clearly than preceding reports the magnitude of the assistance which the Department is rendering to the universities through its grants for special investigations. Outside the field of nuclear physics, much the largest of these grants is the £230,000 over four years to the University of Manchester for the construction and running costs of the radio-telescope at Jodrell Bank; but grants towards capital and maintenance costs for nuclear physics in universities of the United Kingdom during the quinquennium 1952–57 exceed two and a quarter million pounds. This figure looks small enough against the estimates for the Department of Atomic Research, the £53 million of which for 1954–55 include £4 million on civil research and development and £1.8 million for work for the Department by industry and the universities, as does the quarter of a million pounds or so awarded in grants to students and others in the university budgets; but nevertheless, the contribution of the Department is sufficiently large to indicate the repercussions which could flow from sudden curtailment or reorientation of its activities. Moreover, with the formation of the European Organization for Nuclear Research, the Department will be the

medium for official relations with the Organization, and will be responsible for co-ordinating United Kingdom policy on the scientific and administrative questions involved. The United Kingdom's contribution to the budget of the Organization is to be borne on the Department's Vote, and is expected to average £350,000 a year during the seven years while its laboratory is being built, and thereafter some £180,000 a year. In the 1954–55 estimates for the Department, £360,000 is provided for this purpose.

This new interest of the Department indicates, in a minor way, the soundness of the Government's decision to place the major responsibility for the oversight of the development of atomic energy, and particularly for seeing that proper account is taken of the various applications of atomic energy and of nuclear research in the universities, on the Lord President of the Council. The magnitude of these responsibilities for the wise apportionment of the limited resources of Britain in scientific and industrial research and development is clear from the present report, quite apart from those additional responsibilities which the Atomic Energy Corporation Bill will place upon him. Ultimately, with the advice of the Advisory Council for Scientific Policy, he is responsible for the general co-ordination of research and development activities on which the sum of almost £200 million, according to the Civil Estimates, is to be expended in 1954–55. This sum, moreover, does not include any allocation from the Vote for the Atomic Energy Corporation, but it does include some £18 million from the Navy Estimates and £550,000 from the Air Estimates (£315,000 for meteorological research and £235,000 for medical research out of the £748 million provided for production and research in the Defence budget).

To get the exact perspective in which to assess the importance of the Department of Scientific and Industrial Research, it must be emphasized that, even were it possible to obtain an exact figure for the nation's expenditure on scientific and industrial research, we would have still to take account of the Department's contribution in the field of education and also in that of intelligence and in furthering the exchange of information and the use of existing knowledge by industry. When regard is had to all these functions, all of which to some extent fall within the scope of the Lord President's Office, the provision of only £13,300 for that Office in the Civil Estimates suggests that it is under-staffed and ill provided with the means for securing that the national effort in these fields is kept in balance fully concerted.

Considering first the £6,267,210 provided for the Department in 1954–55 from the point of view of research, it must be remembered that this increase of £578,379 includes £360,000 for European nuclear research. It also includes £114,500 for American Aid—Technical Assistance Schemes and £124,400 for the promotion of productivity in the same way, part of which is a contribution to the third function of the Department rather than to research. Some £221,050 is for research to be carried out extra-departmentally, and an additional £91,500 is pro-

vided for the research associations, bringing the total annual income of these associations within sight of £5 million. It should be remembered, however, that the Ministry of Supply alone provides more than £98 million for research and development by industry and the universities, etc., and that the expenditure of the Department's various stations has to be considered against expenditures on research of other Government departments in the same field: the quarter of a million pounds expended on fuel research, for example, must be viewed against the £879,900 expended on research and development by the Ministry of Fuel and Power. Nor does this latter figure take account of any expenditure on research by the nationalized industries themselves.

Such expenditure falls outside the £200 million for research and development shown in the Civil Estimates, as does any income which the universities and colleges receive over and above the £27,932,500 provided in the Civil Estimates for 1954-55. There is no estimate available of the total expenditure of the universities on research; but, at least outside the one field of nuclear research, the grants from the Department of Scientific and Industrial Research cannot play any very substantial part. Their importance probably lies less in their magnitude than in contributing to the furtherance of investigations in neglected fields of decisive national importance.

That could equally be true of the Department's contributions in research generally, both in the applied and the fundamental fields. In magnitude its efforts are small compared with what is done elsewhere: with wise direction their importance can be out of all proportion. This consideration, with the fact that neither such surveys of the work of the research associations as the Advisory Council for Scientific and Industrial Research has made, nor the survey of industry and science in the Greater Manchester area carried out by the Manchester Joint Research Council, have brought to light any evidence of badly misdirected work or poor selection of objectives, endorse the value of the provision for continuity of work which the new financial flexibility of the Department makes possible.

The total expenditure of the Department is probably less than ten per cent of the expenditure on industrial research in Great Britain, though its proportion to the expenditure on scientific research, apart from nuclear research, may well be higher. Expenditure on fundamental research in the United Kingdom was estimated in 1951 as no more than £1.5 million. There seems to be no reason, moreover, in the light of the survey made by the Manchester Joint Research Council, for supposing that scientific and technical man-power is being used wastefully, though the Department's educational activities could well contribute towards increasing the efficiency of utilization of our resources in scientific and technical man-power. Here, however, it is even more difficult to assess the magnitude of the Department's contribution, particularly as that made through the research associations may well become even more important than its system of maintenance grants.

These grants were increased from October 1, 1953, and the thousand or more current grants represent a valuable contribution to the training of scientific and technical man-power.

While the value of the research associations in relation to the training of technical man-power for industry has only come to be recognized fully in recent years, the Conference held last November showed that the importance of their contribution to the expansion of higher technological education is now widely appreciated. Means have still to be formulated for securing that this contribution is fully effective, and on this point the Advisory Council may well comment in a subsequent report. It should also be explored by the Advisory Council on Scientific Policy in its inquiries into the development of technological education; and it would appear possible that the system of maintenance allowances might be used, among other measures, to alleviate the serious shortage of science teachers which is endangering the future supply of scientists and technologists in Britain.

In its present report, however, the Advisory Council is more concerned with the intelligence functions of the Department and its contribution to the more effective exploitation of science by industry. Little information is available as to the resources deployed by the Department for this purpose. Expenditure on headquarters administration, including the Intelligence and Information Division, is only £213,000, and there is no indication of any immediate intention of expanding the Division. Moreover, the effectiveness of the work of such a Division depends largely on the state of the library and information services of the country generally. In this connexion it must be remembered that the Government has shelved the proposals for a Science Centre in London, in spite of the handicap at once imposed by the delay in implementing the scheme for a national library of science and invention supported by the specialized libraries of the learned societies. The Department, it is true, does something to further the improvement of information services through its grant to the Association of Special Libraries and Information Services, and the Director of that Association has pointed out that where the Association's functions touch the activities of the Intelligence and Information Division every care is taken to avoid duplication or overlapping.

That, however, is a small matter compared with the assistance which an adequately housed national reference library of science and technology, linked with regional libraries and the libraries of the learned societies, could render to the functioning of the Intelligence and Information Division or of the library and information services of industry itself. The failure of the Advisory Council, in its reference to this aspect of the Department's activities, to press the Government to reverse the decision regarding the Science Centre is disappointing. Such a Centre, with its interlocked central and specialized libraries, would directly assist in making research results and research facilities widely and effectively known, in ensuring that they are used and applied more quickly by

industry and Government, and that research and development are undertaken on matters of real national importance so that major benefits accrue with increasing speed and efficiency. These are the prime interests of the Intelligence and Information Division. The Science Centre would do more than provide mechanical means for furthering them. It would supply a meeting place for informal contacts and discussions, which are more important than any mechanical devices for striking out new ideas and formulating creative projects.

The duties of the Intelligence Division, which were redefined in 1950, are considered at some length by the Advisory Council in the present report. The Division's responsibilities for the organization and maintenance of liaison with overseas countries are growing; nevertheless, the national reference library of science and invention, located adjacent to the Department, as contemplated in the scheme for the Science Centre, would materially assist the efficiency of all sections of the Division's work. Apart from maintaining the Headquarters Records, Library and Information Services and undertaking scientific and technical surveys and inquiries as required, the Intelligence Division has more recently taken over responsibility for the publications and publicity work of the Department. Moreover, it is not only expected to keep watch on scientific progress and direct attention to advances that may be capable of industrial application: by maintaining touch with current economic and sociological affairs and Government policy in these fields, it is expected to ensure that the Department is kept informed of needs, and that the attention of Government Departments, and especially the central economic staff, is directed to the implications of scientific and technical advances.

Consideration merely of those aspects of the Division's work which are specially mentioned by the Advisory Council in this report suggests that to implement the work of this Division on the scale desirable in the national interest could absorb well-nigh the whole sum at present expended on headquarters administration and a large proportion of the half-million or more pounds by which the Department's budget is expected to increase during the next few years. The investigations for which the Division has been responsible during the past two years in regard to the conservation, and substitution, of raw materials which were either scarce or involved currency difficulties when purchased abroad have already offered savings which probably offset by many times the present expenditure of the Division. The Advisory Council refers, for example, to the discovery of economic uses for waste sulphuric acid, and to an investigation of the technical and economic possibilities of recovering non-ferrous metals from the cinders of pyrites roasting plants, which greatly increased in numbers as a consequence of the recent sulphur shortage. Economic assessments have also been made of long-term trends in the demand and supply of selenium, germanium and vanadium, and the possibilities of increasing supplies by technological improvement have been examined by the Division.

The other aspect of the Division's work stressed by the Advisory Council is that relating to industrial productivity, both in regard to the work of the two joint committees with the Medical Research Council on human relations in industry and that on individual industrial efficiency. A number of research projects have already been placed with universities and research organizations, and the work of the Intelligence Division has clearly contributed much to the selection of the broad programmes of research on which these committees are concentrating their attention. Some of this work is being assisted by grants made available to the Department over the next three years from Conditional Aid funds, and in this context also falls the work of a committee appointed to recommend suitable projects for investigation in production economics and the survey of technological resources and the requirements of industrial firms in the Greater Manchester area carried out by the Manchester Joint Research Council, towards which the Department is contributing a grant of about £3,000.

Both the present report from the Department and that from the Manchester Joint Research Council testify to the continuing value of such inquiries and of this intelligence work and liaison work in general in facilitating the utilization of existing knowledge by industry. Nor does either report warrant any belief that this will be a rapid process, even if the scale of such intelligence work is considerably extended. Such activities clearly lie outside the research functions of the Department as strictly understood; but they are no less important, and it would be well if their cost were more clearly indicated. There are obvious difficulties in indicating that figure precisely, since much work of this type is included in the budgets of the research associations. None the less, an attempt at an approximate figure is desirable, particularly in view of a passage in the account of the work of the Intelligence and Information Division which suggests a tendency to rely on Conditional Aid funds to meet the industrial demand for advisory service and information on such matters as methods and time study, materials handling, etc.

The prominence given to this aspect of the Department's work in this year's report from the Advisory Council is thus welcome. The Advisory Council, in stating that one of its main tasks in the coming year will be to consider how to give effect to the recommendation in the last report from the Advisory Council for Scientific Policy regarding the extension of the use of research and development contracts in the modernization of industry and exploitation of scientific discoveries, again stresses the value of the liaison and advisory services of the research associations. Even if precise figures cannot be given for the educational and information work of the Department, it would seem worth while for the Lord President's office to attempt to offer Parliament a picture of the national expenditure in these varied fields. When the Department's expenditure reaches the anticipated figure of £8 million, much of it will be incurred on objectives which cannot properly be classified as research and should be shown under information or

intelligence, or under university or technological education. Even now the Advisory Council's estimate that the present activities of the research associations amount to about one-tenth of the total research and development activities of civil industry seems rather optimistic. An attempt to show the breakdown of the Department's expenditure not simply by its own Divisions but by such categories as research and development, education, information, liaison and intelligence, would permit a sounder judgment as to whether sufficient effort is being devoted to the latter activities. It is not only in the prosecution of research, but also in training man-power for research and in the provision of information and stimulation of thought that the Department is making an essential contribution to industrial development and the improvement of productivity in Great Britain. Its contribution in these fields has to be judged against the magnitude of the effort which is being made elsewhere in the country, and in the main it should be possible to make the comparison from information available within the organizations for the co-ordination of the activities of which the Lord President of the Council is ultimately responsible. Such an assessment, moreover, is an essential element in the formulation of constructive policy in the field of research and development, in technological education, and in the provision of adequate means for the flow of information. The underlying questions and the appropriate means by which policy is to be implemented should now be very much in the minds of the Lord President and his advisory councils in order to be sure that Britain's effort in these fields is adequate, wisely directed and so concerted as to avoid duplication and waste of effort or resources.

SOCIAL CONDITIONS AND THE DEVELOPMENT OF SCIENCE

Essays on the Social History of Science
 Edited by S. Lilley. (Centaurus, Vol. 3, 1953, Number 1-2.) Pp. 182. (Copenhagen: Ejnar Munksgaard, 1953.) 30 kroner.

THIS book contains twelve essays in English by eleven authors on various features of the history of science from the earliest times to the present, with special reference to their social aspects. There is also a brief introduction purporting to describe the origin and character of the volume. There is much in the book of great interest and value which it would be wrong not to mention. In a brief review, however, attention must be focused on the predominant tone, and, despite its intermittent utterance and the merits of intervening accents, of this there is no doubt. It is clearly sounded by the writer of the introduction: "the fundamental trend of social evolution and the position of science in it . . . is the development of the means of economic production which primarily determines the development of all other human activities, not excluding intellectual and spiritual development. I regret that so many prominent scholars are too timid to accept this general inference as a guidance in their studies" (p. 11).

It may, of course, be sagacity rather than timidity that accounts for this lamentable failure, but, however that may be, the editor's team includes a goodly company of brave men prepared to follow the trumpet-call wherever it leads them. Unfortunately, their logic and perspicacity are not always equal to their courage. Two qualities of the book specially strike the unconditioned reader: first, a tacit change of meaning of a phrase before its use in an argument; second, blindness to the major elements of a process and exaltation into pre-eminence of minor details.

On p. 12, for example, we are invited to accept a definition of science as "in effect, a traditional body of observations, expressed in mutually intelligible symbols . . . and providing rules for concerted action on a common environment—in other words a sort of ideal map or conceptual working model of reality serving as a guide to action". Few would quarrel with this, whether or not it could be improved upon. But two pages later we read: "Social relations are thus inevitably common knowledge, and only common knowledge is a serviceable guide to concerted action". "Common environment" has now become "common knowledge". The man who goes voyaging through strange seas of thought alone is no longer a scientist, and can be made to toe the line. Moreover, common knowledge is identified with social relations, and the way is clear to claim science as essentially a social matter and therefore properly subject to control by the State. The writer does not here take this final step, but he makes it almost irresistible, and others have taken it.

Another example is found in the discussion (p. 59) as to whether a new scientific development is called forth by the internal state of science or by social needs. The writer claims that both are necessary, but the only evidence given for the latter is the obvious fact that, if the social organization regards the development as dangerous and removes the opportunities for making it, then it will not occur. Because social needs can hinder progress, they must be necessary to produce it. On the same grounds, prussic acid can be proved necessary to life.

Oversight of the obvious with magnification of the trivial is illustrated by the statement (p. 61) that the "essential factor" in the discovery of the conservation of energy was "the importation into science of habits of thought that were created by the social agency of the Industrial Revolution". It seems not to have occurred to the writer that the conservation of energy was discovered first of all because energy is conserved, and men intent on finding out what remains constant amid changes must inevitably discover it. The utmost that extraneous influences can do (provided they do not prevent scientific research entirely) is slightly to affect the time of discovery and perhaps the terms in which it is expressed. After reading the account given here, an uncritical reader would probably conclude that under other social conditions it would have been discovered that energy was not conserved.

Similar perversity is seen in the lengthy discussion (pp. 65-9) of the reasons why Galileo and not Leonardo laid the foundations of modern science. The writer sees only two possible explanations, "one in terms of the internal development of scholastic science, the other in terms of social changes". Again, it does not occur to him that at least 99.9 per cent of the reason was that Leonardo was Leonardo and Galileo was Galileo, and that if their dates had been interchanged Galileo would not have painted the

Mona Lisa and Leonardo would not have translated the book of Nature into the mathematical language. The fact that none of their countless contemporaries, though exposed to exactly the same states of scholastic science and social changes, produced anything approaching their achievements would have made this obvious to anyone not bemused by a theory already impregably fortified against the onslaught of facts of any kind.

The influence of scientific knowledge on social history has been badly overlooked in the past, but the fault is not rectified by exaggerating into a major cause the slight effect of social changes on the direction of advance of scientific knowledge. The path from this error of State control of science is fatally easy. If I were not too timid I would express myself strongly on this matter.

HERBERT DINGLE

ARCHAEOLOGY OF LACHISH IN THE NEAR EAST

The Wellcome-Marston Archaeological Research Expedition to the Near East

Lachish 3 (Tell ed-Duweir): The Iron Age. By Olga Tufnell. With contributions by Margaret A. Murray and David Diringer. Text, Pp. 438. Plates, Pp. 10 + 130. 2 Vols. (London, New York and Toronto: Oxford University Press, 1953.) £8 8s. net.

It is now generally accepted that Tell ed-Duweir marks the site of the ancient city of Lachish, which was frequently mentioned in the Old Testament and twice in the ancient Assyrian records. The present volume, well printed and illustrated with excellent photographs, describes the successive foundations of the city and the changes which occurred from approximately 1180 B.C. to the middle of the fourth century. During that long period there seem to have been at least five major rebuildings, of which architecturally the most interesting are those between periods 3 and 1.

There is some doubt as to who may have been responsible for the heavy burning of the city in the twelfth century B.C., though inevitably that event must in some way be correlated with the Peoples of the Sea; but whether or not the destruction was due to a punitive attack by the Egyptians cannot be decisively proved.

In levels 4 and 3 the contents of the tombs as well as what was discovered in the city show that the place was in close contact with Egypt, and the archaeological evidence would suggest that the phase of economic decline which occurred towards the end of this period may well have been due to the fact that it was cut off by increasing pressure of Assyria on North Syria from any northern trade.

In the next phase, which covers the eighth century B.C., there occurs a wheel-burnished pottery of very good quality, a type which had come into general use in the city of Samaria in about 800 B.C. and is a means of providing a valuable synchronization. To this level, too, belongs a series of early Hebrew characters on royal stamps, and these form part of the dating evidence used as a basis for the chronology by Dr. David Diringer.

The end of period 3 is clearly defined by a violent burning and destruction. The evidence supports the author's conclusions that this event is most probably to be ascribed to the conquest by Sennacherib of the

city in 700 B.C., an event recorded not only in the Old Testament and the Assyrian records, but also actually illustrated on a bas-relief discovered by Layard at Nineveh. It is therefore significant that the architecture of this phase was obviously related to a contemporary style in Assyria. The most important of the monuments is a well-dressed limestone podium surmounted by mud-brick, which is characteristic also of the Sargonid occupations at Khorsabad and Nimrud. It appears, however, that this architectural style, so strikingly illustrated in Assyria during the eighth century B.C., has a longer history behind it in Palestine, and this discovery at Lachish therefore raises an attractive problem.

No less interesting architecturally is a stone building in the latest level I, which has been appropriately named the residency of the Persian governor. This is rightly thought not to be Achaemenian in style, but to reflect a Syro-Hittite origin. Here, however, we may perhaps also look to Assyria and find a parallel in a spacious residency of the sixth century B.C. discovered by André at Assur.

This volume contains a great variety of significant material which has been well set out for study by scholars, and in itself provides a mine of important information. A debt is owed to the many authorities who have contributed to this work, but most of all to the devoted labours of Miss Olga Tufnell, who has in exemplary fashion set out the results of this expedition and overcome the very great difficulties which must beset anyone who attempts publication when the leader no longer survives to complete his task. The Wellcome-Marston Trustees are to be congratulated on this admirable achievement.

M. E. L. MALLOWAN

STUDY OF MANAGEMENT

The Principles and Practice of Management

Edited by E. F. L. Brech. Associate authors: R. M. Aldrich, A. W. Field, J. Maddock, and Frank L. Woodroffe. Pp. xvi + 752. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1953.) 50s. net.

SCIENCE or art: academic or practical: graduate or man from the shop floor? These are among the questions which are being hotly discussed in industry to-day; the answers may well decide the future of industrial endeavour in Britain and, inseparably, the whole pattern of the British way of life.

For these and other reasons "The Principles and Practice of Management" is an important book. In it the editor and his associate authors unflinchingly declare their faith that, while management at all levels must be learned by practice, there is also a considerable body of knowledge which can be studied and which no competent manager of to-morrow can afford to ignore. They have been jointly concerned to present some of this knowledge and, for the attempt alone, are to be warmly commended.

The book is divided into six parts. The first presents the analytical framework within which the whole process of management is reviewed and the underlying principles examined. The last is concerned with management in practice and deals with such topics as the functional principle, the use of committees in organization and the place of management in national affairs; both parts have been

contributed by the editor. Between the general principles and practice of management come sections dealing with what are described as the major divisions of management: distribution, production, personnel and control. Each of these has been contributed by a specialist with considerable practical experience in his own field.

Under distribution, the author includes all direct and incidental sales activities, advertising, public relations, warehousing, stock control and transport. The author of the section on production describes such activities as design, production methods, work measurement, production planning, production control, supervision, buying, store-keeping, works maintenance and inspection. The personnel function of management is described as the nervous system of the organization and includes such topics as industrial relations, training and promotion and withdrawals, physical working conditions, employee services and the mechanics of arbitration. Control is mainly concerned with the financial aspects of management and deals with such processes as the preparation and use of budgets, the application of budgetary control, cost control and clerical management.

In a book with such a wide range of authorship, it is not surprising to find over-lapping and variation in principle and details between author and author; the editor has, in fact, made no attempt to circumscribe the authors so that they would write to an agreed body of principles. What is surprising is that so much of the over-lap consists of tedious repetition and that much of the text is loose, contradictory and, too often, inaccurate.

More serious is the claim that this book should be regarded as the reference book for those wishing to practise 'scientific management'. The whole book is unquestionably founded upon good practical experience; this does not preclude the possibility that other students of management with equally good practical experience might present their ideas on management in a different way. It is questionable, too, whether this essay in empiricism might not have served a better purpose if it had appeared, not as a declared reference book, but as a series of much shorter volumes dealing with particular aspects of the management function; each of the volumes could then be superseded as new knowledge and experience are gained in a branch of study which its most ardent exponents still believe to be in the very early stages of growth.

T. H. HAWKINS

INFORMATION THEORY MADE EASY

Probability and Information Theory, with Applications to Radar

By P. M. Woodward. (Pergamon Science Series: Electronics and Waves—a Series of Monographs.) Pp. x+128. (London: Pergamon Press, Ltd.; New York: McGraw-Hill Book Co., Inc., 1953.) 21s.

EVEN an author with Mr. Woodward's ability of explaining complicated matters in simple and attractive language is rather too severely handicapped if he has to explain information theory on 125 small pages, leading up to three specialized chapters on radar, and if on the way he has to explain all the mathematics required, from probability to Fourier

integrals. In this process of condensation and popularization a few things must go by the board. Mathematical rigour is the first victim, and the least regretted. A more serious loss is, in the present case, that this little book may not be a very suitable introduction to the more recondite works on communication theory. Mr. Woodward has followed an 'easy way' of his own invention, which is smooth enough as far as it goes, but is likely to become an impasse later on.

Statistical communication theory centres on Claude Shannon's fundamental theorem: there exists a maximum amount of *certain* information which can be transmitted per symbol *on the average* from an ergodic source through a noisy channel. This maximum can be approached to any limit by suitable coding methods, which deal with the messages in large lumps of symbols. The theorem says nothing about individual messages; evidently a single, short message can convey no certainties whatever.

If $p(x)$ is the probability of a symbol x being sent, if $p(x,y)$ is the joint probability of x being sent and y received, and if $p_y(x) = p(x,y)/p(y)$ is the conditional probability of x having been sent when y is received, the upper limit is

$$H(x) - H_y(x) = -\sum p(x) \log_2 p(x) + \sum p(x,y) \log_2 p_y(x)$$

measured in 'bits' per symbol, that is to say in terms of binary decisions. It is worth while stating this theorem in some detail, because it comprises implicitly perhaps 90 per cent of present-day statistical communication theory—among others the results of Woodward and Davies on radar information. There is, of course, the danger that one may be inclined to forget one or the other of the unfamiliar qualifications in such a long statement.

Mr. Woodward's 'easy way' panders to this human weakness by giving a *detailed* interpretation to the terms which occur in the theorem, and suppressing, at least temporarily, the all-important stipulation 'on the average'. In his view, if a symbol x is received whose *a priori* probability was $p(x)$, there is a transfer of information of the amount $\log_2 p(x)$ bits. If the transmission is marred by noise, one must deduct from this the logarithm of the *a posteriori* probability of x being meant, which is less than certainty. This is a detailed interpretation, quite similar in nature to Ampère's law of the interaction of two 'current elements', or to Poynting's picture of the energy flow, which is a detailed interpretation of the energy integral in Maxwell's theory. The danger of these detailed pictures is that one forgets that they operate with undefined and undefinable quantities. 'Current elements' do not exist, the energy flow density cannot be measured, and information transfer is an empty word until one averages it over long messages. Yet, the didactical and stimulating value of this sort of approach cannot be denied. After all, even Maxwell's field theory is an over-detailed picture, whose purpose is to account for the energy and momentum exchanges between charged particles, which alone are measurable. One must forgive Mr. Woodward all his verbal operations for a stimulating sentence such as "the ideal receiver must directly display the *a posteriori* probabilities".

By and large, this little book admirably fulfils its purpose of making a tasty dish for the moderately mathematically minded engineer out of the driest and most indigestible fare, and giving him a little intuitive understanding in preference to a full-blown inferiority complex.

D. GABOR

THE BRITISH FUNDAMENTAL GRAVITY STATION

NEW SITE AT THE NATIONAL PHYSICAL LABORATORY, TEDDINGTON, MIDDLESEX

THE British National Gravity Base was for many years situated at Greenwich Observatory. Originally a site in the Record Room was chosen, but, in 1927, a new position was selected some 300 metres east of the Observatory in the old Magnetic Pavilion. This building has now been demolished, and in view of the fact that the Royal Observatory is being transferred from Greenwich to Herstmonceux a new

site had to be found. Meanwhile, in accordance with a resolution made by the International Gravimetric Commission at its meeting in Paris in September 1953, the British National Gravity Base was named the British Fundamental Gravity Station.

At the Ninth General Assembly of the International Union for Geodesy and Geophysics held in Brussels in 1951, a resolution was passed by the International Association for Geodesy urging "each country to ensure that their primary station is established in a suitable permanent position".

At its meeting on June 30, 1952, the British National Committee for Geodesy and Geophysics resolved that the British Fundamental Gravity Station should be at the National Physical Laboratory, Teddington, Middlesex, on the site of Clark's (1930) absolute determination of gravity in Room No. 11 of the Metrology Division building. The geodetic co-ordinates (see Figs. 1 and 2) and height of the pillar which Clark used are:

Latitude	51° 25' 18.6" N.
Longitude	0° 20' 21.4" W.
Height (Newlyn datum)	9.23 m.

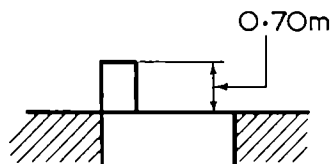
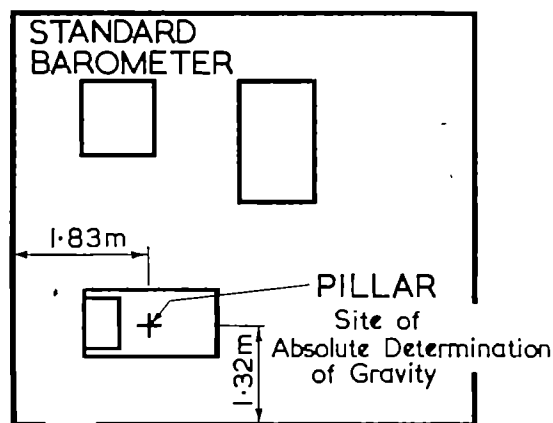


Fig. 1

The pillar, which is situated in the south-east corner of the room, has most of its upper surface at floor-level. There is an extension of height 70 cm. at one end; but this is a later addition and has no connexion with Clark's experiments. Most of the relative measurements of gravity at this site have been made with apparatus standing on the floor, and it is recommended that this practice should be continued. The mean height of the centre of gravity of Clark's pendulum was 95 cm. above floor-level. It was therefore subjected to a mean acceleration of gravity 0.29 mgal. less than at floor-level. The pillar is set 6 ft. into the subsoil and under normal conditions is very steady; but occasionally some disturbance due to nearby building work and heavy machinery has been noticed (Clark, 1930, Cook, 1952).

If circumstances arise which make it inconvenient to observe on Clark's pillar, there are two subsidiary sites nearby which are well compared with the Fundamental Gravity Station:

(1) On the roadway immediately outside the west door of the main east-west corridor of the Metrology Building (Fig. 2) approximately 30 m. west of the Fundamental Gravity Station. The geodetic co-ordinates are:

Latitude	51° 25' 14" N.
Longitude	0° 20' 23" W.
Height (Newlyn datum)	9.24 m.

The value of gravity at this site is known to be the same as at the National Base within ± 0.02 mgal.

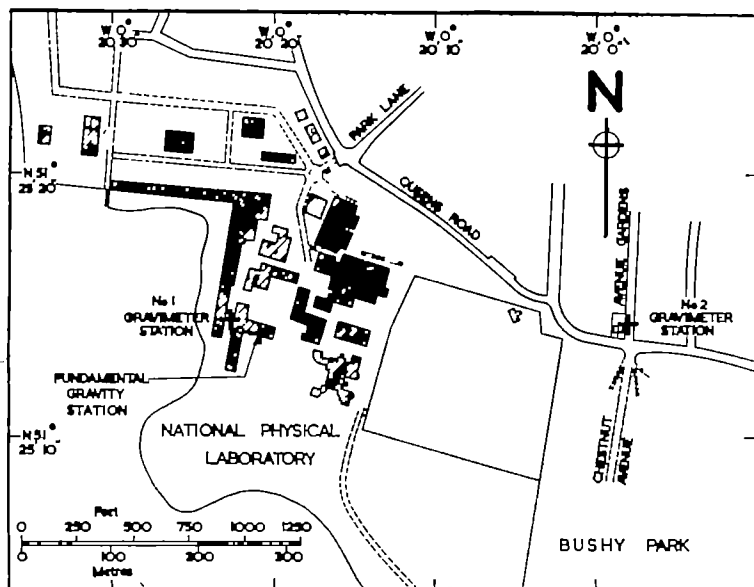


Fig. 2

(2) On the west side of the road in Avenue Gardens, Teddington, about 20 m. from the junction with Park Road (Fig. 2). The geodetic co-ordinates are:

Latitude $51^{\circ} 25' 14''$ N.
Longitude $0^{\circ} 19' 55''$ W.
Height (Newlyn datum) 9.60 m.

The value of gravity at this site is 0.04 ± 0.02 mgal. greater than at the National Base.

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PITHECANTHROPUS, MEGANTHROPUS AND THE AUSTRALOPITHECINAE*

By PROF. G. H. R. von KOENIGSWALD
University of Utrecht

A VERY important group of higher Primates has been discovered in Africa, the Australopithecinae¹. They include *Australopithecus*, *Plesianthropus* and *Paranthropus* from South and most probably "*Meganthropus africanus*"² from East Africa. The position of *Telanthropus* from the *Plesianthropus*-layers of Swartkrans is still under dispute.

The large amount of material now at hand leaves no doubt that the Australopithecinae are members of the Hominidae. With this group they share the upright gait, which can be concluded from the pelvis, used by *Plesianthropus* and *Paranthropus*, and several important peculiarities of the skull and the dentition. The *Australopithecus* from Makapansgat owes the name "*prometheus*" to Dart's suggestion that he knew the use of fire, which, however, was disputed by Broom³. Dart has also suggested that certain battered ungulate humeri from the same site are evidence of a "predatory implemental technique"⁴; however, exactly the same type of damage is caused by hyenas⁵, which are also known from Makapansgat⁶.

* Summary of a lecture given at University College, London, on March 12.

The oldest known, undoubtedly human beings, are the *Pithecanthropi* of Asia, including *Pithecanthropus*, *Sinanthropus* and *Meganthropus*. Do the Australopithecinae represent an ancestral type? Are they really older and more primitive?

First of all, the known Australopithecinae are, geologically, not older than *Meganthropus* and *Pithecanthropus modjokertensis* (not *Pithecanthropus robustus*) from the Lower Pleistocene of Java⁷. In at least two of the South African sites, Kromdraai and Swartkrans, the horse, *Equus*, is found, which is the best guide fossil for the Pleistocene, and at Sterkfontein and Swartkrans we find an extinct carnivore, *Lycyaena*, which even in Europe existed until the Villafranchian⁸. There is no definite proof that any of the other sites is really of Pliocene age.

The best-known hominid from the Lower Pleistocene of Java is *Pithecanthropus modjokertensis*. This form has retained the 'simian gap', which is a very primitive characteristic which might be expected in an early human forerunner; for Remane, in a very careful study, has shown that even in the dentition of modern man there are peculiarities due to his forerunners having much better developed canines⁹. This gap has already disappeared in the full-grown Australopithecinae—although it seems to be present in the deciduous dentition of *Australopithecus africanus*; but while this *Pithecanthropus* in spite of the primitive dentition possesses a typical human entrance to the nose with a well-developed nasal septum, in the Australopithecinae—I quote from a description of *Paranthropus crassidens*—"except that the inner parts of the premaxillaries pass considerably further back, the resemblance of this region to that of the chimpanzee is considerable"¹⁰.

The incisors in *Pithecanthropus* are well developed. In the Australopithecinae they are much reduced, in some cases even below the minimum values known for modern man. Minimum values for central incisors are, for *Paranthropus crassidens* and *Homo sapiens*, upper 7.5 and 8.0 mm., lower 5.0 and 4.6 mm., respectively. The relative values are much higher, as the average length for the first lower molar in *crassidens* is 15.0 mm., in modern man 11.1 mm. The canines are of about the same size in both groups.

In modern man the first lower premolar is only a little smaller than the second (in some Eskimos we still find the reverse), the average being 0.3 mm. But it is 1.3 mm. in *Paranthropus crassidens*. In *Sinanthropus* the first premolar is largest, also in *Meganthropus*, and generally in all anthropoids. This surely is the primitive condition. As a whole, in the Australopithecinae the incisor-canine-premolar group is more reduced not only as in *Pithecanthropus* but also more than in modern man. In connexion with this reduction, the dental arcade shows a typical shortening, which has been demonstrated by Le Gros Clark¹¹.

In spite of all these specializations, the roots of the premolars in *Paranthropus* do not differ in number from those observed generally in the anthropoids. In the lower jaw the second premolar has two roots, and in the upper jaw the first and the second both have three. In *Pithecanthropus* the lower premolar in question is single-rooted, the first upper has three and the second two roots. In modern man two roots in the second lower premolar are extremely rare (one case was observed among 2,089 specimens), while three separate roots occur in the first upper premolar in 3 per cent, three roots in the second in only 0.3 per cent, two in 3.5 per cent of specimens¹².

In the relative size of the molars, the increase in size from the first to the last lower molar, and in the upper jaw the second molar being larger than the first, *Pithecanthropus* shows the same primitive conditions as the Australopithecinae and the anthropoids. There is, however, a tendency for the last upper molar in *Paranthropus crassidens* to be enlarged; this is not found either in the Hominidae (in modern man this molar is often completely reduced) or in the anthropoids.

The deciduous dentition is of great value for the determination of the phylogenetic position. In *Sinanthropus* as in *Pithecanthropus modjokertensis* the first lower deciduous molar has two main cusps—as also the chimpanzee and the orang; in the first form the entoconid is absent, as is common in the anthropoids, in the second very faint. Complete absence of the entoconid in modern man is found in about 2 per cent of specimens only. In the Australopithecinae this cusp is not only developed to the same degree as in modern man (in *Australopithecus africanus* this point is not so clear), but there is also a tendency towards a complete molarization of this tooth, which reaches a maximum in *Plesianthropus transvaalensis* for the upper and in *Paranthropus robustus* for the lower molar; in the latter form, except for its size, this tooth is indistinguishable from the second deciduous molar. There is a certain amount of variability in modern man; but extreme conditions like these have not been observed in a vast collection of modern teeth at our disposal (Bolk Collection, Amsterdam).

This comparison already reveals so many features which must be regarded as a sign of over-specialization that they exclude the Australopithecinae from the ancestorship not only of *Pithecanthropus* but also of *Homo sapiens*.

A greater resemblance exists between the Australopithecinae and the imperfectly known *Meganthropus* from Java; so much so that recently Robinson has included the Javanese species in the same group³. He shows that, especially in the formation of the symphysis, there is a very great resemblance, and he mentions the occurrence of a mental spine in a certain specimen of *Paranthropus crassidens*. We are looking forward with great interest to his final publication.

There are, however, some differences, in which *Meganthropus* is more primitive. There is the basic pattern of the premolars and the first molar, which still have an undivided ridge between protoconid and metaconid, conditions which I could not detect in any of the South African species. The same is true of the presence of a paraconid on the second lower deciduous molar. The first lower premolar is of a more oval outline in the Australopithecinae, whereas in *Meganthropus* it is more angular, as in *Sinanthropus* and Heidelberg man.

The dental arch is probably very similar in both forms, as is evident from a new find, discovered last year¹². This specimen, however, is crushed, and therefore not reliable.

There is not a single feature in the original *Meganthropus* jaw fragment which cannot be matched with other primitive human jaws. In the corresponding part of the *Australopithecus* mandible the two-rooted second premolar must already be regarded as a sign that it belongs to a different category. In fossil human jaws this condition has never been observed; in modern man it occurs in less than 0.02 per cent of specimens. When more is known of *Meganthropus*,

it will probably be found that there are more differences of significance.

However, there can be no doubt that *Meganthropus* and the Australopithecinae have a common ancestor. Such a form must have still had the 'simian gap'—wide *Pithecanthropus*—relatively large canines and incisors, large first lower premolars, and a primitive deciduous dentition. Therefore, it will not fall into the group of the Australopithecinae *s. str.*, and for that reason I cannot agree with Robinson, who claims that the Australopithecinae are "ancestral to the euhominid group" (see ref. 2, p. 37).

Table 1. MESIODISTAL LENGTH OF THE THREE LOWER MOLARS

Lower Pleistocene:	<i>Meganthropus</i>	44.0 mm.
	<i>Pithecanthropus modjokertensis</i>	39.5 mm.
Middle Pleistocene:	<i>Sinanthropus pekinesis</i> (G)	37.7 mm.
	<i>Homo heidelbergensis</i>	36.5 mm.
Upper Pleistocene:	<i>Homo neanderthalensis</i> (Spy II)	34.0 mm.
Recent:	<i>Homo sapiens</i> (White, average)	32.5 mm.

Within this latter group there is a very strong tendency towards a reduction of the dentition, and parallel with it an exaggerated increase in brain capacity (Table 1). The same mesiodistal lengths are for *Plesianthropus transvaalensis* 44.0 mm., and for *Paranthropus crassidens* (average) no less than 48.4 mm., respectively.

Also in regard to the brain capacity the conditions seem fundamentally different. The capacity of the Australopithecinae is a controversial question; Broom gives estimates up to more than 1,000 c.c.¹⁴, and Schepers even calculates "cephalization coefficients" (see Schepers, ref. 14). Let us not forget that only a single skull can be measured, *Plesianthropus V*, and that here the capacity is only 482 c.c.

Most probably in their absolute brain capacity the Australopithecinae bridge the gap which exists between the largest brain of the anthropoids (gorilla with 585 c.c.) and the smallest of the Hominidae (*Pithecanthropus erectus* II with 775 c.c.). There is, however, this important difference: the greatest brain capacity in the Australopithecinae goes together with the largest molars, whereas in man it goes with the smallest molars. We have tried to express this relation in a brain-molar coefficient¹⁵—brain capacity in cubic centimetres divided by the mesiodistal length of the three upper molars in millimetres, both measurements taken on the same skull—the results of which are given in Table 2.

Table 2. BRAIN-MOLAR COEFFICIENTS

(The numbers in brackets indicate the number of skulls measured)		
Chimpanzee (7)	10.9-13.9	average: 11.8
Orang (16)	9.8-12.4	10.9
Gorilla (10)	9.0-13.0	11.7
<i>Plesianthropus V</i>	13.4	
<i>Pithecanthropus modjokertensis</i>	25.8	
<i>Pithecanthropus erectus</i>	24.3	
<i>Sinanthropus pekinesis</i> XI	34.2	
<i>Homo neanderthalensis</i> (Steinheim)	36.7	
<i>Homo sapiens</i> (Europeans, 10)	23.5-37.1	47.8

As we expected, the modern anthropoids form a homogeneous group. The values for *Pithecanthropus* are estimates: a capacity of 1,000 c.c. was estimated by Weidenreich for the skull of *modjokertensis*, and for *erectus* we have used a dentition, not yet described, from a different individual. In Table 2 the anthropoids are sharply separated from the Hominidae; *Plesianthropus* is not intermediate, since it comes within the range of the anthropoids.

This coefficient has still another advantage. If we take a maximum of about 15 for the anthropoids, then the Australopithecinae with their large molars will still remain within the anthropoid group, even with a brain capacity of more than 700 c.c.

Two specimens of the large *Plesianthropus* from Swartkrans have a well-developed sagittal crest¹¹, which is not found in the smaller species. Apart from the fact that this must be taken as a sign of a limited brain capacity, it is to be noted that a sagittal crest in the anthropoids depends upon the absolute size of the species. It is absent from the small gibbon, very rare in male chimpanzees, normal in male orangs and practically always present in the male and often in the large female gorillas. That this structure appears among the Australopithecinae under the same conditions is a very important parallel to the anthropoids, and a significant difference from the Hominidae.

Thus the Australopithecinae apparently are a group of the Hominidae, which most probably did not rise much above the 'anthropoid' level. The reduction of the dentition only affects the face; their increase in brain capacity is slight and depends upon the absolute size of the species; the possession of a sagittal crest in the large specimen parallels the development of the same structure in the anthropoids. It seems that towards the end of the Pliocene period the early Hominidae were separated into several branches—Australopithecinae in Africa, *Gigantopithecus* (and undescribed forms) in China, Pithecanthropi in Asia—and that only one of them, the Pithecanthropi, by a harmonious reduction of the whole dentition and—this is the most important point—by an exaggerated and accelerated increase of the brain capacity, gave rise to the Hominidae, of which group we are the most human members.

¹ Gregory, W. K., and Hellman, M., *Ann. Transvaal Mus.*, 19, 339 (1930).

² Robinson, J. T., *Amer. J. Phys. Anthropol.*, 11, 1 (1953).

³ Broom, R., "Finding the Missing Link", 74 (London, 1950).

⁴ Dart, R. A., *Amer. J. Phys. Anthropol.*, 7, 1 (1949).

⁵ Leakey, H., *Palaeobiology*, 7, 111 (1950).

⁶ Toerien, M. J., *S. Africa J. Sci.*, 48, 233 (1952).

⁷ von Koenigswald, G. H. B., *Rep. Int. Geol. Congr. Great Britain 1948*, part IX, 59 (1950).

⁸ del Campa, D., *Palaeontologia Italiana*, 19, 189 (1913).

⁹ Remane, A., *Z. f. Anat. u. Entwicklungsgesch.*, 88, 391 (1937).

¹⁰ Broom, R., and Robinson, J. T., *Transvaal Mus. Mem.*, 6, 1 (1952).

¹¹ Clark, W. E. Le Gros, *J. Roy. Anthropol. Inst.*, 58, 37 (1953).

¹² Vinner, J. B., *Diss. Zurich*, 1 (1948).

¹³ Marika, P., *Medisch-Nat. Asem. Indon. Indon.*, 100, 25 (1953).

¹⁴ Broom, R., Robinson, J. T., and Schepers, *Transvaal Mus. Mem.*, 4, 1 (1950).

¹⁵ von Koenigswald, G. H. B., *Proc. Kon. Ned. Akad. Wetensch.*, B, 56, 403 and 427 (1953); 57, 85 (1954).

DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH

REPORT FOR THE YEAR 1952-53

THE report of the Department of Scientific and Industrial Research for the year 1952-53* follows the accepted pattern of previous years. Now exceeding three hundred pages, it includes the short report of the Committee of the Privy Council, over Lord Salisbury's signature, and the thirty-eighth annual report of the Advisory Council, signed by Sir Ian Heilbron, together with the usual summary of work carried out by the various research stations and boards and research associations. The appendices include a thirty-seven page classified list of departmental publications issued during the year and the

usual lists of assessors to the Advisory Council, of members of the research boards of the Department, and of grants for special investigations during the year. With the lists of the Department's establishments and of the research associations, it provides the scientific and industrial world with material for a sound judgment as to the worth of the Department's work, though the average member of Parliament may well be glad of some further guidance from the Parliamentary and Scientific Committee in assessing the value which the nation is getting for an expenditure of £5,773,803 gross during the year ended March 31, 1953.

This figure compares with £5,452,165 in the previous year and was reduced to £5,207,455 by various receipts (mainly by the National Physical Laboratory) for work done for other Government departments or for industry, the net increase on 1951-52 being £250,636. On October 1, 1953, the Department employed 4,078 staff of all grades (including 159 part-time), compared with 4,035 (149 part-time) the previous year. Annual grants to research associations, totalling £1,449,635, with special grants of £16,804, were as usual the largest single item of expenditure, followed by that of £860,842 gross, or £546,617 net, on the National Physical Laboratory. Grants for special researches remained at about the same level, £317,321, compared with £313,693 during 1951-52. Most of those listed are spread over a period of years, the largest, apart from the £230,000 for radio-astronomy at the University of Manchester, being £617,500 for the construction of a 400-MeV. proton synchro-cyclotron and other high-energy equipment for nuclear physics research at the University of Liverpool, £354,700 for the construction of a 300-MeV. electron synchrotron and other high-energy equipment for nuclear physics research at the University of Glasgow, £231,500 for the construction of a 1,000-MeV. proton synchrotron and experimental work with a 60-in. cyclotron at the University of Birmingham, £191,000 for the construction of a 140-MeV. electron synchrotron and other equipment for nuclear physics research at the University of Oxford, and £160,000 for construction of a 300-400 MeV. linear electron accelerator at the University of Cambridge. Besides this, grants amounting to as much as £209,500 (University of Liverpool) have been made for running expenditure on nuclear physics research. These grants for running expenditure, which total more than £800,000, extend for five years from August 1, 1952; and by the end of that period the Advisory Council expects these heavy financial responsibilities for nuclear research in the universities to be terminated so as to bring its net annual resources for general purposes to something of the order of six million pounds.

Grants to students amounted to £265,897 net, an increase of £14,856, the number of students in training being 976, compared with 923 during 1951-52, and 413 of these were new. Senior research awards numbered fourteen, seven of which were new, compared with thirteen during 1951-52, and forty-one new grants for special investigations brought the total of such grants to seventy, compared with ninety-one during 1951-52. Of the senior research awards, eight were in physics and three each in chemistry and in engineering; and of the grants for special investigations, thirty-two were in physics, twenty in chemistry, and six each in biology and in engineering. Chemistry claimed 419 and physics 283 of the grants to students; 79 were in engineering,

* Department of Scientific and Industrial Research. Report for the Year 1952-53 (Cmd. 9063). Pp. 315. (London: H.M.S.O., 1954.) 5s. net.

78 in biology, 50 in mathematics and astronomy, 41 in geology and mineralogy, and 26 in metallurgy.

With the exception of building research, expenditure on which decreased by £77,190 to £420,933 net, and on the National Physical Laboratory, which showed a net decrease of £12,718, expenditure on all sections of the work increased, although net expenditure on water pollution research (£61,424), fire research (£28,344), hydraulics (£57,676), pest infestation (£56,636), forest products research (£106,114) and on the Geological Survey and Museum (£206,131) was no more than up to 10 per cent higher than during 1951-52. The larger increases of £17,051 on the Chemical Research Laboratory (to £118,574 net), of £18,538 on fuel research (to £237,692) and of £19,506 on road research (to £292,965) fell well within the same order of magnitude. Only the increases of £27,703 on radio research (to £50,719), of £34,502 on food investigation (to £220,531) and of £78,733 on mechanical engineering, represent more significant increases in the scale of operations.

At a total of £346,157, net expenditure on mechanical engineering ranks fourth in the net outgoings of the Department, and it is now expected that the essential building programme will be completed by 1959 at a cost of about £2 million. More than £500,000 has now been expended on the purchase of the site and on buildings at East Kilbride for the Mechanical Engineering Research Organization, and a staff of more than 250 was built up towards the total of 500-700 contemplated in the original proposals for the Organization. The Advisory Council comments on the much more favourable prospects for the expansion of this Organization during the five years commencing April 1, 1954, under the new arrangements announced in November last, particularly in view of the greater flexibility given by the provision that surplus funds due to underspending in any one year may be carried over to subsequent years. Apart from this, provision has been made for small increases of staff and of expenditure on new buildings during the current financial year both at East Kilbride and for the Hydraulics Research Station at Wallingford. At the latter station some three-quarters of the staff originally contemplated have now been recruited, largely within the past year, and by early 1955 some £500,000 will have been expended on the purchase of the site and provision of buildings. A good beginning has already been made with a substantial programme of research, including experimental studies with models of river estuaries and harbours, theoretical studies of the movement of materials by the action of waves, coast erosion, and the development of instruments. In a study of the changes in the bed of Morecambe Bay, made at the request of the Railway Executive and completed during the year, the Station was able to show that the changes occur cyclically and that the present deterioration of the channel to Heysham Harbour would not be permanent. Progress has also been made in developing research techniques for the study of coastal erosion; a pneumatic tide-generator for use in models has been developed; and the Advisory Council was satisfied on its visit to the Station that important contributions to this branch of civil engineering are already being made there.

The two other establishments of the Department which were formally visited by the Advisory Council during the year were the National Physical Laboratory and the Chemical Research Laboratory, both

of which are at Teddington. The former is by far the largest of the establishments and is also the most diverse in its activities, although work is continually being transferred from the Laboratory to form the basis of new institutions. The Advisory Council, emphasizing the dynamic character of the National Physical Laboratory's organization, points out that much of its work is undertaken to serve the basic needs of industry in general and of the public. Its work on the maintenance of increasingly accurate standards of measurement, although only a small part of the Laboratory's work, remains of fundamental importance, and measurements of the speed of light or the development of a new method of producing diffraction gratings are no longer of purely academic interest but of fundamental importance in both science and industry. Theoretical studies and small-scale experiments in wind tunnels by the Aerodynamics Division of the Laboratory are assisting to define the nature of the problems of the behaviour of bodies moving in air at speeds greater than that of sound, which confront the designer of aircraft; and in the theoretical studies of high-speed flight, and in a wide range of other investigations, the Automatic Computing Engine, designed and built at the Laboratory with the help of industry, is assisting to solve mathematical problems of great complexity.

The Advisory Council's visit equally convinced it of the importance of the work of the Chemical Research Laboratory. It was particularly impressed by the work of the new radiochemical laboratory on the analysis and concentration of radioactive materials, and the importance of microbiological work of the Laboratory is also stressed in the report. The work of this Laboratory has recently been reviewed in these columns (*Nature*, 172, 664 and 832; 1953), and no more need here be added than that the Advisory Council directs attention to the economic value of the work on the corrosion of metals and the recovery of valuable constituents from waste materials or low-grade sources.

From the account of the work of the other establishments of the Department, which occupies some eighty-nine pages of the summary of work, compared with a hundred and thirteen devoted to the work of the research associations, only a few examples of the range and importance of the contribution being made to the national welfare and economy can be selected. During the past year the Joint Fire Research Organization has been able for the first time to examine statistics covering a period of five years and thus to examine trends in certain types of hazard, with the result that steps have already been taken to eliminate or mitigate the worst hazards to which some new types of post-war houses appear to be prone. Considerable progress has been made in the study of smouldering in industrial dusts and other materials such as jute sacking and fibre insulating boards, and fresh light has been thrown by a model technique on the importance of ventilation, in the development and control of fires. Commenting on the first five years of work of the Organization, the Advisory Council expresses the view that the experiment has been completely satisfactory.

The Building Research Station continued its study of productivity, including an investigation at Norwich of the potential value of a rail-mounted tower crane in house-building, which has led to the development of several special pieces of equipment for handling various building materials and to the design of special equipment, such as turntables, to enable the

crane to negotiate corners. In collaboration with the Forest Products Research Laboratory, the Station has shown in laboratory tests and in small-scale trials that a zinc oxychloride paint or plaster effectively prevents the spread of dry rot. Work on the use of pulverised fuel-ash for brick-making has been pursued on a larger scale in collaboration with the British Electricity Authority; and, besides work on prestressed concrete which has established a correlation between behaviour under static and impact loading and on the stiffening effects of walls and floors on structural frameworks, the Station has investigated the soil mechanics of serious breaches in the earth banks of the sea defences in Kent and Essex. The Station has also closely co-operated with the Architects Branch of the Ministry of Education in experimental work on the heating, lighting and acoustics of schools, which has indicated possibilities of economy in fuel by warm-air heating, and a survey of the design and performance of drainage systems is being made with the object of making recommendations for economical and efficient practice.

Under the Food Investigation Organization, wastage surveys have confirmed that the washing of eggs on the farm adversely affects the storage life of the egg. At the Torry Research Station a pilot-scale vertical-plate freezer has been designed which may be suitable for installation on existing vessels, and experiments have indicated that fish can be held in ice for at least three days before freezing without detriment to quality. To meet the needs of the Humber area, a new laboratory was opened in December 1952 as an outstation of the Torry Research Station. A mobile refrigerated store has been designed and built which has been used in various producing areas in England and Scotland for precooling strawberries, raspberries and plums immediately after harvest, to improve the keeping qualities, and for storing Cornish broccoli and spring cabbage; and means of reducing the costs of the two main methods of suppressing the sprouting of stored potatoes are being investigated, for both the use of growth-inhibiting vapours, such as amyl alcohol, and cool storage, are still too expensive. Basic investigations include studies of the properties of the proteins of connective tissue and of the fibrous protein, as it exists in tissues, of the lipids, proteins and soluble extractives of fish flesh, of the chemistry of wood smoke and of the chemical substances which are responsible for the browning, caused by certain enzymes, which occurs when some living plant tissues are injured. The volatile substances produced by apples during storage are being identified and estimated, and a survey is being made of the ascorbic acid content of the chief herbage plants.

In the Forest Products Research Laboratory high priority has been given to the production of preservative-treated plywood. New projects in timber mechanics include investigations on the strength of struts of the type used in light constructional work; on the effect of the construction of plywoods on their strength; and on the design, performance and working stresses of plywood components in structures. General biological work on the common furniture beetle, and further work on the production of hardboards from tropical timbers continued, while studies of beech, oak and Corsican pine showed that at a given humidity the Young's moduli decrease linearly with increase of temperature, although at 90 per cent relative humidity there is evidence of a curvilinear relation.

Increased calls for advisory work continued to be made on the Fuel Research Station, which is exploring the possibility of a relation between the rank of a coal and the germanium content as part of a survey of the occurrence of germanium. Work on the production of metallurgical coke by carbonizing blends of coking coals with other coals continued, and also the study of the factors responsible for changes in the flow properties of residual fuel oils during storage. Work has been started on the adsorption of argon at low temperatures on the iron catalysts used for the Fischer-Tropsch synthesis to see if there is any relation between pore structure and catalytic activity. Efficiencies of up to 90 per cent have been obtained in the removal of sulphur dioxide from flue gas in a scrubber containing a carbon packing in which the grid surfaces are thoroughly wetted at low rates of liquor circulation and the liquor is aerated through a ceramic filter-candle; further work was also carried out with three types of combustion chamber intended to permit the use of solid fuel in industrial gas-turbines. Work at the Station has shown that emission of smoke from forced-draught or natural-draught hand-fired steam boilers can be prevented by the correct use of secondary air, and for the natural-draught types a special fire door has been developed for the purposes.

The publication of maps and memoirs by the Geological Survey has been retarded by the current necessity for concentrating on problems connected with coalfield development, mineral and water resources and hydro-electric schemes; but some progress has been made in acquiring new basic geological data and applying new methods of research. Field work included a survey of the causes and results of erosion in the valleys converging on Lynmouth in North Devon, and the drilling of a borehole on the advice of the Survey averted the necessity for an expensive scheme of piped water supply to Holy Island; in the search for uranium, field investigations of ore deposits were undertaken by officers of the Atomic Energy Division of the Survey in most of the British Colonies, some Commonwealth countries and other territories overseas. A survey of water resources in areas of Bunter Sandstone in Nottinghamshire showed that, in the northern part of the county, reserves will permit a further daily abstraction of about 19 million gallons, and areas of saline water infiltration in chalk areas in Yorkshire and East Lincolnshire have been similarly defined.

In mechanical engineering research the year has been one of consolidation; but the report refers to the work on the fatigue strength of notched and unnotched high-strength aluminium alloys which is nearing completion and to the installation of laboratory equipment for work on materials subjected to high temperature and complex stresses. Experiments on pitot-tubes in water have established that flutter at higher speeds affects the tube coefficient, but can be virtually eliminated by use of a supporting strut with an aerofoil instead of circular section. Two closed-circuit research rigs have been designed for investigating flow conditions in centrifugal and axial flow pumps up to 25 h.p., and a critical analysis of existing formulae used for scaling-up the performance of model water-turbines has indicated that Reynolds-number corrections should be applied to only part of the losses. A comprehensive programme of research on lubrication and wear had particular reference to the operation of bearings at higher speeds and the elucidation of fundamental aspects of the wear

process. Re-calibration of precision measuring equipment transferred from the National Physical Laboratory was completed during the year, and a new portable instrument for measuring profile errors on large marine gears was completed and used on several sets of gears for the Admiralty. Work on the design and development of the prototype apparatus for torque and vibration measurements on small high-speed precision ball-bearings was nearing completion. The properties and behaviour of materials under hydrostatic pressure were also being investigated, while, besides a survey of literature on heat transfer during 1948-50 which was being published, further surveys are planned, as well as a detailed survey of all data on natural convection from vertical surfaces.

The Pest Infestation Laboratory completed its biological studies on the spider beetle, *Ptinus lectus*, and its investigation of the fauna of dry birds' nests, which indicated that old nests built on or inside houses constitute a frequent point of entry for such pests as the carpet beetle. A detailed investigation of the storage of grain under air-tight conditions was in progress, and recommendations, based on experimental work, for a twice-weekly application of 5 per cent DDT dust gave virtually complete control of emergence of blowflies from refuse when adopted by the borough council concerned. The effect of insecticides and fumigants on the carbohydrate metabolism of insects was being studied, and a modified method of paper chromatography was developed for the micro-analysis of mixtures of pyrethrins and their derivatives.

The main contribution of the Radio Research Organization is in the field of wave-propagation, where its investigations have led to a better understanding of the mechanisms of transmission between transmitter and receiver and of the properties of the medium traversed. Ionospheric investigations have included the study of propagation conditions over routes extending to many thousands of kilometres and hourly measurements of ionospheric conditions at seven observatories distributed over the world, while the data accruing from the study of high-frequency noise during 1945-51 have been reviewed in a special report. The Station is also concerned with the properties of materials of importance in the technique of telecommunications. The new Water Pollution Research Laboratory at Stevenage, Herts, is expected to be ready for occupation by the middle of 1954, when the work at present carried out at Watford, Garston, Birmingham and Coventry will be transferred to the new building. The Advisory Council stresses the growing importance of the work on water pollution, and instances the anxiety caused by the condition of the Thames Estuary, to the study of which the Laboratory is at present devoting much of its resources. Other work has been concerned with the effects of customary processes of water treatment on the removal from water of small quantities of radioactive substances, particularly those used in medicine and industry, the treatment of sewage by the process of alternating double filtration, the anaerobic fermentation of liquor from the kieren of cotton, the effects of cyanides on the treatment of sewage in percolating filters, and the development of a standard method for assaying the toxicity of industrial wastes to fish. The work of the Intelligence and Information Division, to which special attention was directed by the Advisory Council in last year's report, receives this year a

special section in the "Summary of Work", stress being laid on the work on the conservation of raw materials and the development of programmes of research on human factors in industry, production economics and industrial engineering.

New or revised terms of grant were offered to seven research associations during the year, as well as to the Research Committee of the Furniture Development Council, and the British Whiting Federation Research Council, while the Commonwealth Mycological Institute is to receive £1,000 a year for the five-year period from April 1, 1953, for the maintenance and expansion of its collection of fungi of industrial importance until the appointment of an additional mycologist, and thereafter £2,000 a year. The British Cast Iron Research Association receives a further block grant of £20,000 for the period July 1, 1953-June 30, 1954, and an additional £100 for each £100 from industry on the same terms as for the previous five years. Its work on the influence of gaseous elements in cast iron continues to increase: a theoretical study of factors influencing the oxygen content has been completed and work commenced on both oxygen and hydrogen. A comprehensive account has been prepared of the effects of composition and structure on electrical resistivity, and progress made in improving methods of sampling and analysis. Negotiations were in progress for the manufacture of the extractor unit specially designed to control respirable dust from pedestal grinding wheels, and work on the protection of marine propellers from corrosion and also of water mains buried in corrosive soils has reached the development stage.

For the period January 1, 1953-December 31, 1957, the British Ceramic Research Association, which now covers all the activities of the ceramic industry, is to receive a block grant of £30,000 a year, conditional on £80,000 from the industry, and an additional £100 for each £100 from industry up to a maximum of £20,000. A major task of the Association continues to be the definition and control of the properties of the raw materials used in the pottery industry, and attempts are being made at the direct determination of the constituent elements in a clay. The principles involved in a satisfactory system of controlling the rheological properties of the slip have been worked out and put into operation in several works, and much attention has been given to the study of chrome-magnesite and magnesite-chrome bricks for steel furnaces. In long-term work on the design and operation of a homogeneous extruded column, a device has been developed for controlling the moisture content of the clay by means of a valve operated by the thrust on the screw, and this device has proved satisfactory in works trials. For the British Coal Utilization Research Association a block grant of £45,000 a year was made for the period January 1, 1953-December 31, 1957, conditional on £190,000 from industry, and a further £50 for each additional £100 from industry up to a maximum of £30,000. Early in the year the new laboratories for work on domestic appliances were opened, and here an electrostatic precipitator has been developed through which the whole flow of flue gas can be passed without appreciable drop and which deposits all smoke on light concentric cylinders where it can be weighed. Work on cyclone combustion has aimed at discovering principles of design for a combustion chamber of suitably limited size to operate under pressure with a gas turbine. Investigations on the effects of coal properties on boiler

performance, using a chain-grate stoker, have been completed, and work on gas producers has endeavoured to ameliorate tar deposition and improve the quality of gas.

The new block grant for the British Gelatine and Glue Research Association for 1953-55 is at the rate of £6,000 a year, conditional on £8,000 from industry, with a further £100 for each £100 from industry up to a maximum of £4,000. The Association, the laboratories of which have only been operating during the past three years, has developed a new technique for fractionating gelatin, based on the solubility in aqueous sodium chloride solution of the complex formed between dodecyl sodium sulphate and gelatin, while an instrument has been designed and produced to check the performance of the testing machine used to grade gelatine and glue as gelling agents. The British Hydromechanics Research Association, the laboratory of which at Harlow was only opened in 1951, is concerned with four main fields of work: general problems in fluid flow; centrifugal and allied pumps and turbines; positive displacement machinery; and seals and glands. Useful work on the hydraulic transport of solids and on the design of pump suction pumps has already been carried out, and for the period October 1, 1953-September 30, 1958, the block grant is £9,000 a year, conditional on £18,000 from industry, with a further £75 for each £100 from industry up to a maximum of £9,000.

The research programme of the British Scientific Instrument Research Association has been drastically pruned. Marked progress is reported in the work on anti-glare glass for instrument windows, the use of digital machines in optical computing, the thickness measurement of metal sheets, humidity-sensitive ceramic elements and the conditions governing the efficient use of diamond-bonded tools. For the period April 1, 1955-March 31, 1958, the block grant will continue at £35,000 a year, conditional on £17,500 from industry, with a further £100 for each £100 from industry up to a maximum of £15,000. The new block grant to the Coal Tar Research Association for the period April 1, 1953-March 31, 1958, will also continue at the present rate of £12,000 a year, but conditional on £45,000 from industry, with an additional £50 for each £100 from industry up to a maximum of £12,000. Current work has included the study of the chemical and physical nature of tar and pitch, the utilization of pitch and of creosote, and service work on such problems as the corrosion of mild-steel distilling equipment by hot tar and tar oils, or the formation of deposits in tar stills. Studies on the chemical composition of a pitch-cooking distillate, the electrophoresis and ultra-centrifuging of tars and solutions of pitch were in progress, and the low-temperature non-destructive hydrogenation of tar oils has been extended to the production of tetrahydronaphthalene and *trans*-decahydronaphthalene from crude and refined naphthalene, and the removal of sulphur from anthracene and phenanthrene.

Besides these grants, two special grants were made towards heavy capital expenditure. One of them, not exceeding £100,000 and conditional on special contributions of £200,000 from industry, was approved towards the new laboratory at Leatherhead of the British Electrical and Allied Industries Research Association where, besides its main work on the generation of electrical energy, the economical transmission and distribution and the most efficient

utilization of such energy and the reliability of equipment, the Association carries out a substantial amount of fundamental research, in which a general theory of electrons in dielectrics has been established so far as concerns the method of approach; and work on the relation between permittivity, loss angle and structure has shown the importance of texture in determining the properties of a dielectric. In rural electrification, good progress is reported in research on the drying of grain, seeds and fodder crops, and promising results were obtained in preliminary work on the destruction of pests in grain by high-frequency electric fields. The second grant, also not exceeding £100,000 and conditional on not less than £300,000 from industry, was to the British Coke Research Association towards a full-scale oven plant to test the possibilities of producing satisfactory coke from blends of coal, including those individually unsuitable.

During 1952 there were forty-one research associations, with an income of four million pounds, of which £1.3 millions came from the Department, compared with twenty-one research associations with an income of £480,000 (£178,000 grant) during 1939. Of the work of the remaining associations, no more can be said here than brief comments on four associations. The formation of the Rayon Section of the British Cotton Industry Research Association in 1928 has contributed largely to the ability of the industry to deal with the new man-made fibres, and the Association has contributed a considerable number of successful devices to improve output or conditions. The Hosiery and Allied Trades Research Association has devised a practical means for synchronizing the rate of feed of yarn to hosiery knitting machines, and a method of impregnating chrome leather with rubber latex, devised by the British Leather Manufacturers' Research Association, permits leather to be waterproofed without losing its ability to transmit water vapour. The Printing, Packaging and Allied Trades Research Association has been concerned with developing the techniques for measuring and comparing odour with the object of assessing the possibility of odour contamination from materials used in making the packing.

The annual report of the Department thus presents a picture of widely varied activities affecting almost every aspect of industry and national welfare. It is a picture, too, of increasing co-operation and of an organization which is intimately interlocked with the national research effort in Great Britain as a whole, whether concerned with defence, the development of atomic energy or the fundamental research in progress at the universities. The wise direction of this expenditure of effort is a matter of continuing concern to industry and the universities as well as to Parliament, and the present annual report goes far to provide a basis for sound judgment as to the wisdom with which the Department's activities are planned and its objectives selected. The very complexity of the relations disclosed, however, demonstrates the shortsightedness and wastefulness of some of the reductions in expenditure imposed on the Department during recent years. The material supplied in this latest annual report should be used by scientific workers and industrialists to make sure that in future the activities of the Department are guided and modified by views of a sufficiently long range to avoid wasteful repercussions and secure that the nation reaps some return from activities to which it has once been committed.

OBITUARIES

Dr. G. P. Bidder

GEORGE PARKER BIDDER died on December 31, 1953, in his ninety-first year—for many years president of the Marine Biological Association, sometime president of Section D (Zoology) of the British Association, secretary of the Linnean Society during 1928–31 and vice-president in 1924 and 1932, a founder of the Association of British Zoologists, and a distinguished authority on the sponges. He was a man to whom more than one generation of biologists were indebted for counsel and for help. At no time a professional scientist, he was perhaps the last of his kind—that of the great amateur biologists of the past century.

He was the grandson of his namesake, the famous 'calculating boy', and had something of the same remarkable quality of memory. At the first council of the newly formed Society for Experimental Biology in 1923, the secretary disclosed that the blackboard on which was written the constitution had been wiped clean without any record in writing. Dr. Bidder adjourned the meeting for fifteen minutes: he then wrote out from memory the entire constitution; and the secretary then read the minutes.

Bidder had his first taste of biology as a boy at Harrow, a taste confirmed when in 1881 he spent a year under Ray Lankester at University College, London. He then went up to Trinity College, Cambridge. This was just after the tragic death of Francis Maitland Balfour at the height of his power as comparative anatomist and embryologist: as Bidder once said, "a great and exciting laboratory—ruled by a ghost". On leaving Cambridge in 1886 he occupied the University Table at the Stazione Zoologica, at Naples. So began his long association with marine biology.

In 1890 he married Miss Marion Greenwood, a biologist who had already done elegant work on the physiology of *Hydra*. Many Cambridge biologists remember with fresh regret her death in 1932. For a few years they lived at Plymouth, while he worked at the Plymouth Laboratory in close touch with Dr. H. J. Allen. They settled in 1902 at Cavendish Corner, Cambridge. Unfortunately, he soon became seriously ill and was a semi-invalid for more than ten years. But he was not a man to be put down by circumstance, and after his illness he returned to assume the active position in biological affairs which he retained for the rest of his long life.

He did this in his own way. By present standards he was unconventional—or it were better to say that he had the patrician ability to make his own system of conventions. Few young biologists to-day would suddenly decide to buy a Neapolitan hotel—'Parker's'—as he did in 1889; and to run it successfully and for some time. Also few to-day could happily and successfully organize a life in which the active day started towards evening, and one did not retire until the early hours of the next morning. But unlike the Watertons and the Frank Bucklands of the past century, he used his freedom from convention and his independent and disinterested position to seize the moment to do things essential for biological advance—things that could not be done by the professional scientist, and which can never be done simply and in time by official bodies. In the early days of the Plymouth Laboratory it was scientifically necessary to buy a vessel for fishery work. There

were official difficulties about doing this. Bidder himself borrowed the money to buy a ship, hired it to the Association for the work, and ultimately arranged for it to be sold at a profit—characteristically using the proceeds to found the Ray Lankester Investigatorship. Such long-sighted and timely action was characteristic of his life. It was action of this sort by him that perhaps more than any other single factor helped the Stazione Zoologica at Naples to survive two world wars and to regain its present great position in international science.

Two major scientific periodicals, the *Quarterly Journal of Microscopical Science* (of which he became for long the owner) and the *Journal of Experimental Biology*, owe their continued existence to his help and wise advice. These were only some of his many-sided activities. He was no narrow specialist, but a man of culture with major interests spreading far outside biology. For many years he was managing director of the Cannock Chase Colliery.

Bidder enjoyed conversation and scientific speculation; but his interest was in real phenomena rather than ideas alone. For that reason, his scientific contributions were not just the elegant speculations of a dilettante, but a real influence on current biological thought; particularly those concerned with the form of organisms. Though, to the regret of many of his friends, he was never elected into the Royal Society, he will, I believe, prove to have been one of the most interesting figures of early twentieth-century science. He was a lasting example of how much good can be done by the individual action of a shrewd, kind, disinterested and able man. More than one generation of biologists learnt from him the value of approaching research, not in a spirit of narrow specialization but in one which is best summed up in a characteristic opening phrase of his own—"It has often occurred to me to wonder . . .".

C. F. A. PANTIN

Mr. S. F. Ashby

SYDNEY FRANCIS ASHBY was born on December 31, 1874, at Rockferry, Cheshire. His father was a gifted artist and his mother the daughter of a naval officer. He studied first at the University of Liverpool, then at Edinburgh, where he graduated. Afterwards he proceeded to the Universities of Halle and Göttingen and spent some time in Denmark studying the bacteriology of water. He returned to England and worked at the Rothamsted Experimental Station as Carnegie Research Fellow under Sir Daniel Hall. While there he was offered the post of microbiologist to the Government of Jamaica, which he accepted in 1906. He married in January 1910 Miss Cork, daughter of Mr. William Cork, supervisor of revenue, and returned to England in June 1910. He studied in London until 1912, when he went back to Jamaica, specifically to see what could be done about the dreaded Panama disease of bananas, caused by the fungus *Fusarium oxysporum* var. *cubense*, which had been introduced into the Island in 1911. He remained in Jamaica until February 1921, when he was appointed professor of mycology at the Imperial College of Tropical Agriculture, Trinidad. He occupied the chair for a little over five years and returned to England in April 1926 as senior mycologist at the then Imperial Bureau of Mycology. On the resignation of the late Sir Edwin Butler in 1935 he was appointed director of the Imperial Mycological Institute, as it was then known. He relinquished this post in 1939 on retire-

ment. Early in the Second World War he suffered the grievous loss of his son, who was killed in his first operational flight as an observer in the Royal Air Force.

Throughout his scientific career Ashby was thorough and reliable in his work. His first research concerned the assimilation of nitrogen by a soil bacterium. In Jamaica he studied banana diseases and within six months published a valuable account of the work in the Bulletin of the Department in 1912, including a section on Panama disease. For the control of the disease he recommended the isolation of all infected areas, the boundary being set one chain distant from the nearest diseased plant. This treatment was immediately successful and no diseased plants were found outside the boundary line seven to nine months after treatment. Every diseased tree within the affected area was cut down, the stool dug up, and the whole burnt. There is no question but that Ashby's prompt and sound action saved the Jamaica banana industry from ruin and allowed the farmer a means of keeping the disease in check. Unhappily, in the course of years farmers became impatient at having to leave so much land out of cultivation and ultimately Ashby's policy had to be moderated and finally abandoned as the disease gradually got out of control. If his method had been consistently followed the progress of Panama disease would have been impeded much more than it actually was; but in any event, the slowing up of the spread of the disease allowed planters valuable time to consider alternative crops. While in Jamaica, Ashby also published in 1920 notes on a disease of coconut caused by *P. palmivora* and another by *P. parasitica*, and in 1921 an account of sugar-cane mosaic.

Throughout his life he maintained his interest in the important genus *Phytophthora*. In 1925 he became interested in *Stilbum flavidum* on coffee and succeeded in isolating and growing the fungus in culture, proving conclusively that the *Stilbum* is a state of the perfect form *Omphalia flavida*. In 1928 he published with W. Nowell a joint study on the fungi of Stigmatomycoses, a classic paper on a peculiar group of fungi attacking cotton bolls, one of which, since named *Erasmiothecium ashbyi*, proved during the War to be a producer of riboflavin. His next important contribution was on bacterial wilt of

bananas, which he showed was due to *Bacterium solanacearum* (Kew Bull., 14; 1927). In 1929 Mr. Ashby visited Dominica in connexion with the outbreak of red rot disease of limes and was able to assure the authorities that the prevalent fungus *Sphaerostilbe repens* had been present in the island since 1911 and was not a virulent pathogen. On his return he concluded an important paper on leaf scald of sugar-cane, naming the causal organism *Bacterium albilineans*. Two papers on *Phytophthora* followed, concerned with the production of sexual organs, and one on *Gloeosporium* strains isolated from bananas. When Mr. Ashby retired in 1939 he had accumulated on behalf of correspondents a vast amount of knowledge about the genus *Phytophthora*; but he did not put this information in print. He died on March 6 after a prolonged period of illness and is survived by his widow and one son. S. P. WILTSHIRE

Mr. J. G. R. Elbo

JOHN GREGGERS ROSENSTAND ELBO died on March 11 at Carlton, near Cambridge, at the early age of thirty-one. He joined the staff of the Scott Polar Research Institute in 1946 as part-time assistant in Scandinavian studies, and specialized in the problems of northern Scandinavia, Svalbard and Greenland. He took his degree in modern languages at Cambridge in 1950, and then decided to study for a research degree in Eskimo philology. Meanwhile, the first sign of serious illness had become evident as early as 1948; despite apparently successful treatment his health slowly deteriorated, until in September 1953 the last illness began.

We regret to announce the following deaths:

Mr. Roland Austin, during 1927-48 joint editor of *Antiquity*, aged seventy-nine years.

Mr. E. Graham Clark, C.B.E., secretary of the Institution of Civil Engineers, a post from which he was due to retire this year (see *Nature*, March 6, p. 427), on April 23, aged sixty-four.

Prof. Methodi Popov, director of the Institute of Biology, University of Sofia, on April 20, aged seventy-three.

NEWS and VIEWS

The Australian Academy of Science

THE Australian Academy of Science was founded in 1952 (*Nature*, 170, 549; 1952); on February 16, H.M. the Queen, during her visit to Australia, presented a Royal Charter to the officers and Council-elect of the Academy. This is the first time in nearly 300 years that a reigning British sovereign has founded a scientific society, the only previous occasion being the founding of the Royal Society of London by Charles II. The names of the Council-elect are announced in the *Australian Journal of Science* for February; these have to be ratified at the first general meeting of the Academy during April 6-7 when twenty-seven new Fellows will be elected. Also to be ratified at the meeting are the nominations of the following officers: *President*, Prof. M. L. Oliphant; *Treasurer*, H. R. Marston; *Secretary (Physical Sciences)*, Dr. D. F. Martyn; *Secretary (Biological Sciences)*, Dr. A. J. Nicholson.

New Zealand Science Review

To commemorate the recent visit of H.M. the Queen and H.R.H. the Duke of Edinburgh, the January issue of the *New Zealand Science Review* is a "Royalty and Science" number (12, 1; 1954). After a brief editorial article welcoming the Royal couple, the address entitled "Science and the Scientific Worker" given by the Duke before New Zealand scientists on January 13 is reported in full. This meeting was organized by the Royal Society of New Zealand, with its president, Dr. W. R. B. Oliver, in the chair. During his speech, the Duke conveyed greetings to the Royal Society of New Zealand from the Royal Society of London and the British Association for the Advancement of Science. Then follows an informative article reviewing the history of the interest shown by royalty in science. I. D. Dick contributes a more specialized article on "Royalty and Science in New Zealand". It was also a happy

thought to include in this number the complete presidential address delivered by the Duke before the British Association meeting in Edinburgh in 1951, for that address is still recalled by many as one of the most forcible speeches made in recent years. Dr. Oliver gives a historical account of the Royal Society of New Zealand, which was founded in 1867 as the New Zealand Institute. In the same issue it is announced that publication of a new series of *N.Z. Science Abstracts* is to begin shortly, and that it is hoped that an abstract will appear within a month of the publication of each paper.

Memorial to Dr. W. G. Duffield at Canberra

A MEMORIAL tablet to the late Dr. W. G. Duffield was unveiled by his daughter Miss Joan Duffield, in St. John's Church of England, Canberra, on January 3. Dr. Duffield was the founder and first director of what is now the Commonwealth Observatory, Mt. Stromlo, Canberra, holding office from 1924 to the date of his early death in 1929 at the age of fifty years. The service was held in the presence of many who had been associated with the early development of Canberra. Lessons were read by the present director and Commonwealth Astronomer, Prof. R. v. d. R. Woolley, and the Right Rev. E. H. Burgmann, Bishop of Canberra and Goulburn, who also dedicated the tablet. Sir Robert Garran, in an address recalling the foundation of the Observatory, referred to the earnestness of purpose with which Dr. Duffield fought for so long and for so hard to realize his life's dream. The tablet, in bronze, displays an engraving of the solar tower telescope at Mt. Stromlo which had been one of Dr. Duffield's major interests.

Botany at Swansea: Prof. Florence Mockeridge

PROF. FLORENCE MOCKERIDGE is retiring at the end of the present session from the chair of biology at the University College of Swansea which she has held since 1921. She was the first holder of the chair and was appointed shortly after the establishment of the College. Naturally she found nothing in existence and she had to lay the very foundations of a Department while simultaneously coping with the demands of teaching. No one who has not had such an experience can readily imagine the sheer hard work involved in such an undertaking, which few of the present generation have had to face and which fewer still will have to face in the future. Our forbears who started scientific teaching in the universities a century ago had none of the complex needs of modern laboratory work to cope with, while students were few and the pace was more leisurely. Prof. Mockeridge devoted her whole energy to the task, which made heavy inroads upon her slender reserves of strength, but she has the unselfish satisfaction of looking back upon a job well done for the benefit of others. She leaves a flourishing organization of well-equipped laboratories, growing numbers of students and an increasing research output.

The Department is primarily botanical with herself as head. Zoology has not hitherto been taken up to full degree standard and was under a zoological lecturer, although Prof. Mockeridge was responsible. Her successor will not have this dual responsibility, as zoology is soon to become independent. Prof. Mockeridge was trained under the late Prof. Bottomley at King's College, London, and did much of the work in investigating the chemistry of his 'auximones', which anticipated the discovery of the

auxins. Always young in heart, she has retained a close interest in and sympathy with the work of younger people and has stimulated the research she could no longer do herself. She has been a kind and generous colleague and a wonderful hostess to her fortunate visitors.

Prof. H. E. Street

DR. H. E. STREET, who succeeds Prof. Mockeridge, was born in 1912. He graduated in 1938 at Nottingham as an external student of the University of London, with first-class honours. His first post was on microbiological control work in industry; meanwhile, he enrolled as an evening research student at Birkbeck College under Dr. F. O. Steward. Upon this foundation Dr. Street has built an impressive amount of research on cell metabolism, distinguished for its thoroughness and its grasp of the fundamental problems of chemical physiology. Since going to Manchester in 1949, Dr. Street has established a vigorous research school and has made his laboratory a centre for the study of metabolism in excised roots. He brings to his new post experience as lecturer in the Universities of Nottingham and Manchester, a wide knowledge of modern techniques in plant physiology, and a store of energy and enthusiasm which will be of great benefit in the programme of development which is about to begin in the biological sciences at University College, Swansea.

Katharine Berkan Judd Awards for Cancer Research

THE Katharine Berkan Judd Awards of the Memorial Center for Cancer and Allied Diseases and its research unit, the Sloan-Kettering Institute, have been made to the following for their outstanding contributions in the field of cancer research: Dr. Everts A. Graham, of the Washington University School of Medicine, St. Louis; Dr. George O. Gey, of the Johns Hopkins University School of Medicine, Baltimore; Dr. L. H. Gray, of the Mount Vernon Hospital, Northwood, Middlesex, England; and Dr. Sidney Farber, of the Harvard Medical School, Boston. Dr. Graham's Award is in recognition of his work in cancer surgery and in medical education; he was the first surgeon to remove an entire lung in the treatment of cancer, the patient being still alive to-day twenty years after the operation, and he was also one of the first to work on a possible relationship between lung cancer and tobacco smoke. Dr. Gey's contributions have been in the field of tissue culture, which is important not only for cancer but also for studies of poliomyelitis and other medical research, and in particular he made the long-term culture of human cancer cells known as the HeLa strain, which has been used as a medium for the growth of the polio virus all over the world. Dr. L. H. Gray is a physicist whose speciality is the investigation of the effect of ionizing radiations in normal and cancer cells and the application of this knowledge to radiation therapy. The complementary side of Dr. Gray's treatment by physical methods is represented by Dr. Farber's work in the field of cancer treatment by chemicals; among Dr. Farber's most notable achievements have been his demonstrations that certain chemicals can preferentially damage the cells of certain types of acute leukaemia in children, and this has opened a new field in cancer chemotherapy. The Awards are given in memory of Katharine Berkan Judd, who left a portion of her estate to the Memorial Center for recognition of achievements in the field of cancer, and the recipients, who by

tradition are members of other institutions, are selected by the Sloan-Kettering Division of Cornell University Medical College, the executive faculty of the Memorial Center.

Gulmarg Research Observatory, Kashmir

THE Universities of Aligarh and of Jammu and Kashmir have jointly established a high-altitude research station at Gulmarg in Kashmir, to be known as the Gulmarg Research Observatory, and the Observatory was officially declared open on April 4 by Prof. A. H. Compton, chancellor of Washington University. The Observatory, which is under the direction of Prof. P. S. Gill, head of the Department of Physics, Aligarh, is at a height of 9,000 ft., which, as Prof. Compton pointed out, compares favourably with other high-altitude laboratories such as Mexico City (7,500 ft. and about the same magnetic latitude), Huanacayo, Peru (10,500 ft.), Echo Lake, Colorado (10,000 ft.) and Jungfraujoch, Switzerland (11,800 ft.). Work at higher altitudes is also possible at Khillan Marg (11,000 ft.), which is one hour distant, and at Apharvat (14,000 ft.), which is three hours distant. Prof. Compton, who was the first to initiate cosmic-ray studies in India when he carried out cosmic-ray measurements at Tosh Maidan, Kashmir, in 1928, continued: "The latitude and longitude are of special significance in cosmic-ray measurements, in comparing results with those obtained elsewhere. The latitude is that at which most rapid cosmic-ray changes occur with changing latitude. The longitude is close to that where maximum effects of the earth's magnetic field are felt. Comparison of results found here with those from other stations are thus of special significance with regard to the effects of the earth's magnetic field on the primary cosmic rays, a subject of major theoretical interest".

Suffolk Naturalists' Society: Schools Supplement to Transactions

THE encouragement of younger people in field natural history and practical biology should not be left entirely to the schools, especially since most observational work and recording has to be done at nearly all times of the year and out of school hours. Apart from this, there are certain institutions, especially local natural history societies, which can obviously offer keen enthusiasts special local information and other facilities which are not to be found elsewhere. Some natural history societies do much to encourage young people by inviting them to meetings and organizing excursions. The Suffolk Naturalists' Society has already done much in this connexion by establishing contact with the local schools and making them members; and now it has taken an even more effective step by publishing for the first time a Schools Supplement to its own *Transactions* (8, Part 3; 1953). The Supplement is intended to be a Schools' Natural History Societies' Journal, in which can be published observations and notes received from member schools—together with suggestions of simple work which schools or young naturalists may undertake. In this first issue is a very practical article on "Field Work on Hedges", giving an easily read account of the plant and animal ecology of hedges. This is followed by an article on "Mice and Voles", which not only informs but is also calculated to inspire and stimulate interest. Two shorter articles follow, on "Moles on Flooded Land" and "The Geology of Suffolk" (Part 2). Practical instructions are then given on how to use a micro-

scope for explaining everyday experiences (in this case, why a nettle-leaf stings). Birds naturally loom large in the field naturalists' interest, so a short article on "Bird Identification in the Field" will prove very useful. There are two reports of biological work by young people: (1) "Investigations into Pellets of the Short-eared Owl" by John Petford; (2) "A Weed Study" carried out by Form IIB of Halesworth Area School.

This is an excellent journal from all points of view and will undoubtedly do much to encourage the development of interest in natural history in Suffolk and, it is hoped, well beyond the borders of the county. It is to be published twice a year. Further information concerning the objectives of the Suffolk Naturalists' Society and the Schools' Supplement to its *Transactions* can be obtained from the Earl of Cranbrook, Great Glenham House, Saxmundham, Suffolk.

"Standardized Plant Names" in Australia

THE booklet bearing this title is the revised version of a list, originally published in 1942, of standard common names for the more important Australian grasses, other pasture plants and weeds (Bull. No. 272, Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia, 1953; n.p.). This new index, which runs to some 132 pages, is a thorough revision of the earlier work, the information having been drawn from all the many reliable sources available. The approved botanical name, its synonyms and the standard common names for each species are given in two lists which permit of simple cross-reference.

Veterinaria Italiana

THE first number of *Veterinaria Italiana*, a review of animal hygiene, prophylaxis and therapy, edited by the General Directorate of Italian Veterinary Services with Prof. Giuseppe Caporale as responsible editor, is an attractively produced journal, issued from the Experimental Zooprophyllastic Institute, Teramo (No. 1, January 1954; obtainable from the Institute at c.o. postale N. 20/988; no price). It is a monthly journal containing scientific and practical articles, together with news of veterinary medicine in Italy and the rest of the world. It is intended that the original articles shall have summaries in English, French and German; but in the first issue some articles are in Italian only. This first number is divided into a scientific and a practical part. In the scientific part Dr. L. Badiali writes on the use of isonicotinic acid hydrazide for the prophylaxis of bovine tuberculosis; Dr. A. Mantovini on the culture of canine distemper virus on the chorio-allantoic membranes of eggs; Prof. V. Cilli on animal diseases transmissible to man; and Dr. G. Guarini on the complement deviation reaction for the diagnosis of infective anaemia of the horse. The practical part of the journal contains notes on the therapy of a number of diseases, and the number is completed by reviews of books, abstracts of current veterinary literature and veterinary news. Veterinarians and others interested in the remarkable recent advances in veterinary science will watch the progress of this new journal with interest.

Geographical Studies

WITH the geographical staffs in United Kingdom universities now almost double their pre-war numbers,

and with the publication space of most geographical and closely related journals almost halved as a result of war-time restrictions and rising costs, the emergence of a new journal to cope with the increasing flow of research material now available is not surprising. *Geographical Studies* has been founded very largely by younger geographers to meet this need. The first number, running to some forty thousand words, is well produced apart from an over-reduction of some of the maps and diagrams: it includes research articles from six contributors ranging over a wide field, and also contains notes of geographical interest. Prof. F. K. Hare deals with the boreal conifer zone, while Prof. P. R. Crowe attempts, in an article on the effectiveness of precipitation, a graphical analysis of Thorntwaite's climatic classifications. Dr. G. J. Butland describes the changing land occupancy in southern Chile, and Dr. W. R. Mead, in an article on the language of place, draws some interesting conclusions from a study of two Finnish dictionaries. Geomorphology is represented in an ingenious article from Miss Alice Coleman on the use of the height-range diagram in morphological analysis, and in conclusion J. H. Hubbard contributes some new data on the rainfall of the Gold Coast. It is proposed to issue *Geographical Studies* at least once and possibly twice a year initially. The journal is published from Birkbeck College, Malet Street, London, W.C.1 (price 10s.), and inquiries should be addressed there to Dr. G. H. Dury.

British Mathematical Colloquium

THE sixth British Mathematical Colloquium was held at Cambridge during April 6-8. Among the hundred and seventy members were Prof. A. Zygmund, at present working in Cambridge, and Prof. L. Schwartz, of Paris, who attended as foreign guest of honour. The first day was devoted to algebra, and the following papers were read: Dr. D. Rees, an aspect of multiplicative ideal theory; Dr. W. Ledermann, some recent work on group characters; Mrs. H. Neumann, Hopf's problem; Dr. C. H. Dowker, dimension of metric spaces. The day devoted to analysis included papers by Prof. Zygmund on Hilbert's transform and its generalizations, Mrs. D. Stone on measure algebras, Dr. H. G. Eggleston on extremal geometrical problems, and Prof. Schwartz on distributions and applications to partial differential equations of hyperbolic type. The geometry (third day) discussed was chiefly algebraic: Prof. J. G. Semple, on enumerative geometry and the method of degenerate collineations; Dr. D. B. Scott, on self-correspondences on algebraic curves and surfaces; Dr. J. A. Todd, on canonical systems on algebraic varieties; Prof. D. G. Northcott, on some local and global aspects of the foundations of geometry. The 'splinter groups' worked with enthusiasm during the intervals available from the main programme, and exchanged much information on problems now being actively investigated. On the afternoon of April 7, a visit was paid to the University Mathematical Laboratory. It is hoped to hold a seventh colloquium in 1955, at the University College of the South-West, Exeter.

Wittgenstein's Philosophical Views

In January 1929, Prof. Ludwig Wittgenstein returned to Cambridge after an absence of more than fifteen years. His return was largely due to the influence of Prof. F. P. Ramsey, who described him

as "a philosophic genius of a different order from anyone else I know". Wittgenstein began lecturing in 1930 and continued until 1933. Records of the lectures and subsequent discussions were kept by Prof. G. E. Moore, who has prepared an account of them in a recent issue of *Mind* (63, No. 249; January 1954). Among the topics considered were some general questions about language, some special questions in the philosophy of logic and mathematics, as well as behaviourism, solipsism, idealism, realism, "the grammar of the word 'God' and ethical and aesthetic statements". The journal also contains a detailed critical notice of Wittgenstein's book "Philosophical Investigations" by P. F. Strawson.

Leicester Museums and Art Gallery: Annual Report for 1952-53

THE forty-seventh annual report of the City of Leicester Museums and Art Gallery for the year April 1, 1952-March 31, 1953 (pp. 44+4 plates; 1953), reflects the steady and continued achievement of this institution. It is an attractive, illustrated production and records faithfully the consolidation that has taken place after the period of considerable reorganization undertaken since the end of the Second World War. The year has been one of close and friendly liaison with local cultural societies, and much extra-mural work has been accomplished in collaboration with the appropriate department in the University College. This means that the Museum buildings are in use on most evenings during the week. The outstanding acquisition of the year was a fine overmantel and oak panelling from Ragdale Hall, Leicestershire, made possible through the generosity of the trustees of the Friends of the Museum Fund.

Non-Destructive Testing Group of the Institute of Physics: Meeting in Birmingham

WITH the appearance of new techniques for proving or sorting materials and components, some of which are complementary to radiography, the Industrial Radiology Group of the Institute of Physics has changed its name to the Non-Destructive Testing Group, and, under its new title and with extended terms of reference, the Group is holding a summer meeting, which will be on a wider field of physical methods of non-destructive testing than on previous occasions. The meeting will be held in the Chancellor's Hall, University of Birmingham, during July 7-10 and will be open both to members and non-members of the Group, subject to the limit of lecture-room capacity of about three hundred persons. Prof. A. J. Murphy, professor of industrial metallurgy in the University of Birmingham, will give an address on the evening of July 7, and on the succeeding three days six papers will be presented dealing with the following topics: isotope techniques; image intensifiers; diffraction mottling; theory and application of electrical and magnetic methods of non-destructive testing; propagation of elastic waves in solids; and selected topics in ultrasonic testing. Abstracts of the contributed papers will be circulated shortly before the meeting, and the proceedings will be reported in the bulletin of the Group and in the *British Journal of Applied Physics*. Enrolment forms (to be returned by May 31) and further information can be obtained from the Deputy Secretary, Institute of Physics, 47 Belgrave Square, London, S.W.1.

Earthquakes during January

EARTHQUAKES caused minor property damage on January 12 near Wheeler Ridge, California (magnitude 6), and on January 25 in the island of São Miguel in the Azores. Earthquakes were also reported as 'felt' on January 2 at Arenas del Rey in Spain; on January 17 in Central Honshu, Japan; on January 18 near the west coast of Greece; and on January 27 and 28 near the coast of Guerrero, Mexico. The greatest earthquakes during the month were on January 12 and 13 (magnitudes 7 and 7½) off the South Island of New Zealand; and other shocks of magnitude 6 and greater occurred, in addition to those mentioned, on January 1 in the Sawee Sea, on January 20 in the Pacific Ocean south of Mexico, and on January 21 in Kenya. Reports have been received from individual stations at Durham, Lwiro (Belgian Congo), Pasadena, Strasbourg, Toledo and Uccle; and from the United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association.

The Night Sky in May

New moon occurs on May 2d. 20h. 22m., U.T., and full moon on May 17d. 21h. 47m. The following conjunctions with the moon take place: May 4d. 13h., Venus 3° S.; May 5d. 20h., Jupiter 2° S.; May 16d. 07h., Saturn 8° N.; May 21d. 08h., Mars 1° S. In addition to these conjunctions with the moon, Mercury is in conjunction with Aldebaran on May 19d. 11h., Mercury being 7.2° N.; Venus is in conjunction with Jupiter on May 23d. 12h., Venus 1.5° N.; and Mercury is in conjunction with Jupiter on May 31d. 19h., Mercury 2.2° N. Mercury, in superior conjunction on May 8, is too close to the sun to be seen in the early part of the month; on May 15 and 31 it sets at 20h. 25m., and 22h., respectively, but in the former case this is only 40 minutes after sunset. Its close approach to Jupiter on May 31 has already been pointed out. Venus is an evening star, its times of setting on May 1, 15 and 31 being 21h. 25m., 22h. 05m. and 22h. 30m., respectively. The visible portion of its illuminated disk varies from 0.922 to 0.856, and its stellar magnitude from -3.3 to -3.4. Mars rises at 0h. 10m., 23h. 30m. and 22h. 35m. on May 1, 15 and 31, respectively. It has an eastward motion in the constellation Sagittarius until May 23 when it is stationary, after which its motion is westward. Jupiter sets at 23h. 15m., 22h. 30m. and 21h. 45m. on May 1, 15 and 31, respectively. Its eastward movement from east of ζ Tauri to west of η Geminorum is easily detected. Saturn rises at 18h. 35m., 17h. 35m. and 16h. 25m. at the beginning, middle and end of the month, respectively, and is close to α Virginis; it can be seen until the early morning hours. No occultations take place during May. The η Aquarid meteors are active at the beginning of the month, attaining a maximum about May 6; the radiant is at R.A. 22h. 24m., Dec. -1°, very close to η Aquarii, from which the shower derives its name. For a long time it was believed that it was associated with the debris of Halley's Comet, but there is now some doubt about this.

Announcements

THE Royal Meteorological Society announced the following awards at the annual general meeting held on April 28: Buchan Prize for the period 1949-53

to Dr. R. S. Scorer for his outstanding contributions to dynamical meteorology; Hugh Robert Mill Medal and Prize for 1954 to Mr. C. K. M. Douglas, for his outstanding contributions to our knowledge of the causes of rain. Darton prize awards were also announced as follows: First Prize, for 1953, Messrs. B. J. Mason and R. Ramanadham. Canadian Prizes for 1953: First Prize, Dr. W. L. Godson; Second Prize, Mr. G. W. Robertson.

THE Worshipful Company of Clockmakers (Candlewick House, 116 Cannon Street, London, E.C.4) has decided to institute an award for outstanding achievement in the field of horology. It will take the form of a gold medal, to be known as the Tompion Medal of the Worshipful Company of Clockmakers, and will be awarded, without regard to nationality, not more than once a year.

COLONEL S. J. M. AULD has been elected president of the Institute of Petroleum for the year 1954-55. Colonel Auld was previously president of the Institute in 1937-38.

MR. K. B. ROSS, who until 1951 was general refineries manager for the Anglo-Iranian Oil Co. at Abadan, and has since then been on the Board of Messrs. Costain-John Brown, Ltd., has been appointed director of production in the Industrial Group of the Department of Atomic Energy at Risley. Mr. P. T. Fletcher, chief engineer of the Ministry of Works, has been appointed deputy director (engineering services) in the Industrial Group.

THE following appointments have been made in the University of London: Dr. F. E. Camps, lecturer at the London Hospital Medical College, to the part-time University readership in forensic medicine tenable at that College; Dr. G. E. Francis, senior lecturer at St. Bartholomew's Hospital Medical College, to the University readership in biochemistry tenable at that College.

THE Committee of Privy Council for Agricultural Research and Nature Conservation has appointed Mr. David Lowe, a prominent Scottish horticulturist, and, after consultation with the President of the Royal Society, Mr. J. N. Ritchie, chief veterinary officer of the Ministry of Agriculture and Fisheries, to fill two vacancies on the Agricultural Research Council.

FOLLOWING the resignation of Mr. A. G. Peacock, for seven years secretary of the Scientific Instrument Manufacturers' Association, Mr. E. D. Hart, for many years with Marconi Instruments, Ltd., and lately with the Equipment Division of Mullard, Ltd., has been appointed deputy director of the Association. Miss G. E. Moss, formerly clerk to the Council, has now taken the position of secretary.

THE Section of Mathematical Statistics of the Australian Commonwealth Scientific and Industrial Research Organization has now become the Division of Mathematical Statistics, with headquarters in Adelaide, and its officer-in-charge, Dr. E. A. Cornish, is now chief of the new Division. The main task of the Division is to provide research workers of the Organization with special help in planning their researches and analysing and interpreting their experimental results.

ERRATUM. In the communication entitled "Proposal for a New Ether-Drift Experiment", by Dr. L. Essen (*Nature*, April 17, p. 734), line 23, for "± 1 part in 10¹⁰" read "± 1 part in 10¹¹".

EXTENSION TO THE METALLURGY DIVISION OF THE NATIONAL PHYSICAL LABORATORY

THE extension to the Metallurgy Division of the National Physical Laboratory, which was opened by Sir Lawrence Bragg on April 6, has been made necessary by the continuous development of techniques for the examination of the fine structure of metals and by the growth of interest in the properties of materials at very high temperatures. It consists of a two-story building having a total floor area of about 11,700 sq. ft., of which about 8,800 sq. ft. is experimental working space. Its purpose is to accommodate three Sections of the Division—the Ceramics Section, the X-Ray Section and a new Radioactive Tracer Section. Each portion of the building has been designed to meet the requirements of the particular type of work that will be undertaken in it.

The Ceramics Section is on the ground floor and consists of five laboratories and offices, together with a large furnace room. The Section is mainly concerned with the development and production of refractory ware for use under exacting conditions, especially those involving very high temperatures. Facilities are available for crushing, grinding, forming and drying ware, and the furnace room will permit firing on a considerable scale. Space is also available for physico-chemical research and for the needs of specialized experiments and measurements.

Also on the ground floor is a set of rooms for experimental work on the application of radioactive tracer techniques to metallurgical problems. The purpose is to provide a place where these techniques can be applied under suitable conditions to metallic samples, and to assess their value in metallurgical research. The plan underlying the design and equipment of the Section has been to provide facilities for carrying out on metals of all but the highest activity most of the operations normally applied to metals in a research laboratory. The main feature is the foundry, a lofty, well-lit room equipped with melting furnaces, casting equipment, heat-treatment furnaces, a small bar- and sheet-rolling mill and a suitably protected safe for storing active isotopes. Provision has been made to handle active metal in quantities up to about 6 lb. Next to the foundry is a combined workshop and laboratory for metallographic preparations, and next again is a combined chemical and physical laboratory in which chemical analyses and measurements of activity will be carried out. The Section is approached through a semi-sealed door and changing rooms, and is provided with its own air-conditioning system arranged so as to produce a slightly negative pressure. This avoids the possibility of contamination passing to the rest of the building, which is kept at a slightly positive pressure by its own system of air circulation. At selected points in each room, openings to the extract duct are provided, to which extensions to hoods over machines and other equipment may be attached. The rooms are designed to be easily washed down, and have floor ducts and sinks down which all active liquid passes to delay tanks situated under a separate pump house. Separate sinks and drains are provided for non-active liquids (for example, cooling water from pumps, etc.). Warning bells and klaxon alarms are incorporated

in the air-conditioning and delay-tank systems to indicate any abnormal feature of their operation.

The upper floor is designed for X-ray diffraction studies of metals and for electron microscopy. The main feature is a single, very large room divided by means of easily removable partitions into a number of cubicles and small laboratories, each of which is intended to contain a single piece of equipment and can be independently darkened. In this way the need of the individual worker to have sole control of his own equipment is combined with adaptability. As a corollary to the use of removable partitions, all services in the Section are carried in a carefully planned system of wall and floor ducts. In addition to the standard services provided throughout the building, there are, in this Section, a circulating system of clean distilled water at 50 lb./sq. in. pressure and 20–25° C. temperature for cooling purposes, and a quiet phase of 230-volt a.c. for apparatus requiring short-term mains stability. Among the pieces of equipment at present installed may be mentioned units primarily intended for standard X-ray techniques, two sets for Geiger-Müller counter work for high-precision measurements of diffraction-line intensities and preferred orientation, one set for work requiring a fine-focus source of radiation, electron microscope and a soft X-ray spectrograph with a recording microphotometer.

In his opening address, Sir Lawrence Bragg referred to the history of the Division, going back to 1901 and to the succession of eminent men who had filled the post of superintendent—Sir Harold Carpenter, Dr. W. Rosenhain, Dr. C. H. Desch, Dr. C. Sykes and, at present, Dr. N. P. Allen. He then went on to say: "I am particularly pleased to be opening the new extension, because all three of its main interests are related to interests of my own. One Section will be devoted to X-ray work, particularly on metals, and I should like to remind you how greatly our country has contributed to this field; in fact, it has been at times almost a British monopoly. Brilliant work on alloys was started by Westgren and Phragmen in Sweden in the early days, but it fell to Owen and Preston here, and to Bradley, who was then with me in Manchester and afterwards came here, to develop the patient study of the structure of alloys which has helped us so much to understand them. Sykes also made contributions to the theory of alloy structure. His experiments and the theories developed by Williams enabled us at Manchester to start the investigations into the order-disorder phenomena, which have exerted a great influence in the study of many other problems of the solid state. The X-ray study of alloys is a rich field to explore, and it is proper that there should be a strong centre of this work at the National Physical Laboratory.

"Another fascinating line which you are to develop here is the application of tracer techniques to problems of metal physics. Metal physics is an extraordinary subject; there is such a vast accumulation of empirical knowledge about the behaviour of metals and so little satisfactory theory behind it. It is an extraordinary position for a subject which has such

immense technological importance. This seems to me to be an ideal activity for the National Physical Laboratory. You will have a special laboratory designed for the purpose and will find by experience how this new technique can be applied. You will be marking a trail which it will be easier for others to follow".

Sir Lawrence then said it must appear he was claiming a finger in every pie; but ceramics are really artificial minerals, and mineral structures have long fascinated X-ray analysts. Minerals are structures of great stability and resistance to change, and these are just the qualities needed for refractories. The juxtaposition of the ceramics and X-ray sections seemed to him completely appropriate, and collaboration between them should be very fruitful. He concluded: "The National Physical Laboratory was founded to keep the country's standards, but it has come to have another function, that of setting standards in experimental investigation. It ought to preserve a judicial and impersonal attitude, contain equipment which is a model of its kind, and be a centre to which one can go for advice, advice which depends upon an impartial review of what is going on all over the country and a readiness to adopt the best ideas whatever their source. With its unique position it has a great part to play in the interchange of ideas and the improvement of standards".

The opening of the main door of the building was performed by Sir Lawrence using a presentation key, made in the Division, of titanium and ornamented with eight other metals, each of which represented some major research or development activity of the Division during the fifty-three years of its existence.

H. A. SLOMAN

UNIMOLECULAR GAS REACTIONS

A MEETING to discuss the theory of gas-phase unimolecular reactions and its applications to specific reactions was held in the Department of Chemistry, University College, London, on December 4. Dr. N. B. Slater (Leeds) opened the discussion by describing his approach to the problem. If it is assumed that a molecule has a few unstable states (r) of high energy which have lifetimes L_r^{-1} , then if p_r is the probability of the r th state, ω the effective collision frequency per molecule and k the rate-constant,

$$k = \sum_r \frac{p_r \omega L_r}{L_r + \omega} \quad (1)$$

At high pressures ($\omega \gg L_r$) the majority of energized molecules will be deactivated, and (1) reduces to (2):

$$k = \sum_r p_r L_r \quad (2)$$

The reaction-rate is thus the rate at which a molecule possessing at least an energy E_0 attains a critical configuration. The critical configuration may be taken as a large extension of one of the internal co-ordinates of the molecule. Treating the latter as a classical vibrating system, it can be shown¹ that the rate of reaction is given by

$$k = \nu \exp(-E_0/RT), \quad (3)$$

where

$$\nu = \frac{\sum_i \alpha_i^2 \nu_i^2}{\sum_i \alpha_i^2}, \quad E_0 = \frac{q_i^2}{\sum_i \alpha_i^2} \quad (4)$$

The ν_i are the vibration frequencies of the molecule and α_i the amplitude factors, both of which are constants of the molecule in question; q_i is the critical extension of the co-ordinate corresponding to decomposition, and E_0 the activation energy. No attempt is made in the theory to calculate E_0 .

At low pressures the rate of dissociation becomes of the same order of magnitude as the rate of deactivation, and so (1) no longer reduces to (2). However, on the basis of the present theory, it is possible to develop from (1) an expression for k/k_∞ , the ratio of the rate at any pressure to the limiting rate at high pressure². Calculations have shown that small molecules should show first-order kinetics only at impossibly high pressures, six or more atoms being necessary to give first-order rates below a pressure of one atmosphere. Dr. Slater showed that the rate as given by (3) and (4) is essentially reproduced at high temperatures by a quantum treatment and that these expressions are little altered by taking account of anharmonicity of the vibrations. The relation of the theory under discussion to that of Kassel and to the transition state theory was described.

Dr. A. F. Trotman-Dickenson (Manchester) gave a critical survey of the experimental field. He stated that, in his opinion, only eight decompositions have been reasonably fully investigated over a large range of pressure, which undoubtedly exhibit quasi-unimolecular behaviour: they are nitrous oxide, dinitrogen tetroxide, nitrogen pentoxide, fluorine oxide, CH_3NNCH_3 , C_2H_6 , *cyclo*- C_3H_6 , and *cyclo*- C_4H_8 . The last two decompositions³ provide the most straightforward examples of the dependence of a unimolecular rate-constant on pressure. The observations could not be explained on the original Hinshelwood-Lindemann theory. But either the Kassel theory or the Slater theory will fit the results for cyclopropane very well, though the latter theory is much to be preferred because no arbitrary parameters are introduced. A table of the relative efficiencies of various inert gases in maintaining the rates of five reactions was shown by Dr. Trotman-Dickenson, from which it can be inferred that 'kinetic theory' collisions between two complex molecules result in an equilibrium distribution of internal energy between the molecules, whereas equilibrium is attained in only one collision in ten of nitrogen with a complex molecule.

The pyrolyses of alkyl chlorides were discussed by Dr. K. E. Howlett (Bedford College, London). Although two mechanisms—unimolecular and radical chain—have been observed, about ten compounds studied have proved to be pure unimolecular. In each case, critical pressure regions exist, and the number of degrees of freedom required to account for these are reasonable⁴. Inert gases, while having no effect upon the high-pressure rates, are capable in various degrees of restoring the low-pressure rate to the high-pressure value. Ethylene has been found to be the most efficient in transferring energy, and helium the least⁵. Further, the efficiencies appear to be of the same order as predicted by the kinetic theory, in marked distinction to the calculations of O. Zener. It is also observed that the range of efficiencies is never very great. Finally, Dr. Howlett reported that Miss A. M. Goodall has found the inhibited decomposition of trichlorethylene to be a homogeneous second-order, non-chain process, in accord with Slater's predictions for small molecules.

Dr. F. J. Stubbs (Oxford) dealt with the pyrolysis of hydrocarbons. A limiting reaction-rate in the presence of inhibitors is observed, which is independent of the nature of the inhibitor and identified with a molecular process. The rates are found to be pressure-dependent. Two modes of decomposition are found, as typified by ethane and *n*-pentane. In the former case the activation energy is independent of pressure, and there is a single transition from second to first order as the pressure rises. In the latter case the activation energy falls as the pressure rises, and the reaction order changes from two at low pressures to one, then towards two and finally reaches one again at high pressures. For compounds like *n*-pentane, the rate can be divided into two terms each corresponding to a unimolecular reaction, one of which (predominant at low pressures) is characterized by a high H and A , and the other (predominant at high pressures) is characterized by a low H and normal A . In the latter case, it is suggested that the activation process is essentially confined to a C—C bond, whereas, in the former, C—H activation is involved as well. This is assumed to give rise to a multiplicity of reaction paths, corresponding to the carbon nucleus being surrounded by a mobile sheath of hydrogen atoms. The magnitude of A and H can be interpreted on this basis.

The pyrolysis of mercury alkyls in the presence of nitric oxide as a chain inhibitor was described by Dr. B. Gowenlock (Swansea). Under these conditions both a nitroso compound and an oxime were obtained in the products. In the case of dimethyl mercury* the activation energy was about 6 kcal. mole⁻¹ less than the energy required to break both bonds, and this is considered to be the energy required to break the first Hg—C bond; the frequency factor was about 10¹³ sec.⁻¹. However, with di-*n*-propyl mercury* and di-isopropyl mercury¹², H corresponded to the energy required to break the two bonds and A was of the order of 10¹³ sec.⁻¹. The increase in the frequency factor corresponds with the spreading of the activation energy over two bonds.

Further evidence in this connexion was provided by Dr. E. Warhurst (Manchester). While diphenyl mercury behaves like the dipropyl mercury compounds, phenyl mercuric chloride and bromide show the same type of behaviour as dimethyl mercury. This series of compounds shows an interesting type of behaviour as the number of oscillators in the reacting molecule increases. Further evidence for frequency factors of 10¹⁴–10¹⁵ sec.⁻¹ coupled with 'high' activation energies is provided by a series of carbonyl-containing compounds studied by M. Szwarc and his co-workers.

Dr. H. O. Pritchard (Manchester) pointed out that an explanation of the observed differences in behaviour of dimethyl mercury and di-isopropyl mercury upon pyrolysis would probably have to await a further interpretation of the vibrational spectra of mercury di-alkyls. Again, uncertainties in the strengths of C—H bonds make it possible that the activation energy for the di-isopropyl mercury decomposition may be significantly greater than the sum of the energies required to break the two Hg—C bonds. Such behaviour is actually observed in azomethane, where the activation energy is approximately double the sum of the dissociation energies for the two N—CH₃ bonds. However, in this case it is reasonable to assume that the activation energy

is all concentrated in one N—CH₃ bond, since the frequency factor is only 10¹⁴ sec.⁻¹.

The case of dimethyl mercury was referred to again by Dr. L. H. Long (Exeter), who reported an activation energy for the unimolecular decomposition in excellent agreement with that of Gowenlock, although obtained by a different technique. As was also noted by the previous two speakers, the frequency factor tends to rise with increasing pressure.

Dr. J. O. Hirschfelder (Wisconsin) emphasized the importance of a theoretical calculation of energy transfer at surfaces. There is strong experimental and theoretical evidence to indicate that molecules obtain their energy of activation by collision with the walls rather than with other molecules in the gas phase. This would require a considerable modification of the Slater theory and lead to somewhat different results. In connexion with the Eyring theory of bimolecular reaction-rates, Dr. Hirschfelder underlined the necessity of allowing for rotation in the activated complex. With the H₂I₂ complex, for example, unless this factor is allowed for, the rate comes out too small by a factor of about 1/300. A value in better agreement with experiment is obtained if rotation is considered. It is to be hoped that the future development of reaction-rate theory will include both unimolecular and bimolecular reactions in a uniform treatment.

Some results of experiments on the pyrolysis of alkyl bromides carried out by Drs. J. H. S. Green and P. J. Thomas and Mr. G. D. Harden were described by Dr. A. Maccoll (University College, London)¹¹. Whereas secondary and tertiary bromides decompose cleanly by a unimolecular mechanism, the primary compounds decompose by a mixed chain-unimolecular mechanism, the chain part of which, however, may be eliminated by the use of cyclohexene as an inhibitor. In all cases of unimolecular decomposition, the frequency factors are of the order of 10¹³ sec.⁻¹. An interesting series is that of the normal bromides, for which (apart from ethyl) the activation energy is constant and the rates appear to approach a limiting value as the chain-length increases.

Prof. H. C. Longuet-Higgins (King's College, London) outlined a quantal attack on the problem of reaction-rates, which he has been developing in collaboration with Mr. P. W. Higgs. In the case of a molecule capable of dissociation and which cannot be considered as being in a pure quantum state, the outward flux across a given value of a co-ordinate may be calculated. For an assembly of simple harmonic oscillators in thermal equilibrium, such a calculation leads to the quantal expression for the reaction-rate. It is found that at high temperatures (the classical limit) equation (3) is recovered, but at intermediate temperatures the rate expression departs from (3); in particular, a finite rate is predicted at 0° K. It was suggested that perhaps the theoretical criterion of reaction $q > q_c$ would need to be re-examined in the light of the experimental criterion, which is the appearance of new chemical species. The full solution of the problem in the case of many degrees of freedom is not yet available.

The flexibility of the Eyring treatment in its ability to account for a wide variation in v was referred to by Dr. B. Atkinson (Imperial College of Science and Technology, London). High value of v can be interpreted in terms of a 'loosening' of the molecule in the transition state and low values in terms of a 'stiffening'.

A number of points emerged as to the present state of knowledge of unimolecular reactions. In the first place, there now seems to be a large number of well-established gas-phase unimolecular reactions. Secondly, experimental investigations of the low-pressure region have enabled relative collision efficiencies for energy transfer to be estimated. Thirdly, there appears to be quite a wide range of frequency factors. Fourthly, it is desirable to extend the theoretical treatment along quantum lines. Finally, recognition of the possible multiplicity of reaction paths may be a fruitful line of approach.

The meeting closed with an expression of gratitude to Prof. C. K. Ingold, of University College, London, through whose interest the conference was made possible.

¹ Slater, N. B., *Proc. Roy. Soc., A*, **194**, 112 (1948).

² Slater, N. B., *Phil. Trans., A*, **248**, 57 (1953); *Proc. Roy. Soc., A*, **218**, 224 (1953).

³ Pritchard, H. O., Sowden, R. G., and Trotman-Dickenson, A. F., *Proc. Roy. Soc., A*, **217**, 563 (1953); **218**, 416 (1953).

⁴ Howlett, K. H., *J. Chem. Soc.*, 3605, 4487 (1953).

⁵ Howlett, K. H., *J. Soc. Chem. Indust.*, 1175 (1953).

⁶ For all references see Peard, M. G., Stubbs, F. J., and Hinehewood, O. N., *Proc. Roy. Soc., A*, **214**, 471 (1952).

⁷ Chilton, H. T. J., and Govenlock, B. G., *J. Chem. Soc.*, 3232 (1953).

⁸ Govenlock, B. G., Polanyi, J. C., and Warhurst, H., *Proc. Roy. Soc., A*, **218**, 209 (1953).

⁹ Chilton, H. T. J., and Govenlock, B. G. (to be published).

¹⁰ Chilton, H. T. J., and Govenlock, B. G., *Trans. Farad. Soc.*, **49**, 1451 (1953).

¹¹ Green, J. H. S., Harden, G. D., Maccoll, A., and Thomas, P. J., *J. Chem. Phys.*, **21**, 178 (1953).

SCIENTIFIC AND TECHNICAL DOCUMENTATION IN TURKEY

TECHNICAL Assistance projects in Turkey, some of them operating, others to come into operation if and when funds are available, cover a great variety of subjects: public administration, economic research, civil aviation, statistics, maternal and child health, diseases control, water resources development, oil resources development, fisheries development, hydrogeology, seismology, and various others. Bibliographical and documentation services, needed by many of them, are also included.

The National Bibliographical Centre is one of three Unesco projects under the Expanded Programme of Technical Assistance in Turkey. It was set up in 1952, with the assistance of two library experts: a specialist in bibliography, from France, and a specialist in documentation, from the United Kingdom. The Centre is housed at the National Library in Ankara and, apart from co-operating with Technical Assistance projects, maintains close contact with government departments, university faculties, scientific societies, educational institutes, research stations, industrial undertakings and, of course, other libraries.

The main objective of the Bibliographical Centre is to assure the availability of information to all Turkish programmes for scientific, technical and economic development. This emphasis on Turkish affairs does not, however, preclude it from collaborating in a system of international exchanges of scientific information and so render valuable service to the region, and to the world.

With financial aid earmarked for the purpose by Unesco Technical Assistance, the Centre brought together a much-needed collection of handbooks, monographs, bibliographies, catalogues and other

library tools in many different languages. This useful reference library, open to *bona fide* research workers, has meanwhile become indispensable to staff and readers alike.

Under its regular programme, Unesco has established in Istanbul a branch office of its Middle East Science Co-operation Office, the headquarters of which are located in Cairo. The Istanbul Office acts as an outpost of Unesco in Turkey, and among its activities has been the *ad hoc* supply of scientific information requested by Turkish scientific workers. The United States Information Service offers similar facilities within the range of United States sources. The Middle East Science Co-operation Office in Cairo issues an abstracting journal in the English language which covers the Middle East countries and includes several periodicals published in Turkey.

Fuller coverage of Turkish periodicals in the pure and applied sciences, technology and so on, is now provided by "Türkiye Makaleler Bibliyografyası" ("Bibliographie des articles parus dans les périodiques turcs"), issued by the National Bibliographical Centre. It is published at irregular intervals, is arranged by Universal Decimal Classification numbers, with the titles of articles in Turkish and French, and has an author index. Translations or abstracts of specified papers, and microfilms of the original texts, are supplied on request.

As a means of meeting and co-ordinating incoming demands for foreign articles which may be available in Turkey, the Bibliographical Centre has compiled, and keeps currently up to date, a union catalogue of foreign periodicals in Turkish libraries. It is now in its second edition.

Scientific papers published in other journals are obtained as microfilms from abroad, against payment in Unesco coupons or, mostly, on an exchange basis. The first exchange arrangement was concluded in March 1953, between the National Bibliographical Centre in Ankara and the Centre National de la Recherche Scientifique in Paris. This placed at the disposal of Turkish men of science a substantial part of the world's scientific literature, and makes Turkish contributions available to scientists in the West. The microfilm laboratory at the Turkish National Library, previously almost exclusively engaged on the copying of manuscripts, has adjusted itself admirably to the new tasks, and a microfilm camera and microfilm reading machines have been imported from Britain.

Approach to documentation may be two-fold—short-term and long-term—one taking care of immediate needs and the other making provision for potential requirements. It has been the policy of the Centre to prepare for both, trying to do justice at the same time to border-line cases, of which there are many.

Inquiries for documentation were received from quarters interested in subjects as widely apart as: palaeontological research; fish culture and fish industry; methods of preserving and utilizing agricultural products; and industrial accidents and workmen's compensation—to mention only a few. It had, moreover, been agreed between Unesco and the World Health Organization, also represented in Turkey, that every possible help should be given to medical libraries and medical documentation in Turkey. The Bibliographical Centre was also called upon to act as liaison for a direct approach between research and study projects in Turkey and their opposite numbers elsewhere. An agricultural research

station was referred to the Food and Agriculture Organization; an industrial information unit put in touch with the Department of Scientific and Industrial Research; a chemistry department with the Gmelin Institut für Anorganische Chemie; and a government agency with the International Organization for Standardization. Such liaison has been essential, for, through it, has been created a broader footing for scientific and technical documentation; in the terms of Technical Assistance, "the activity started on the right lines".

LUCIA MOHOLY

LATERITES AND BAUXITES OF ANTRIM

THE first memoir to be published by the Geological Survey of Northern Ireland*, prepared by Mr. V. A. Eyles and other workers, will be widely recognized as a contribution to the geochemistry and mineralogy of laterite and bauxite of outstanding importance and permanent value. Equally welcome will be the promised companion volume on the detailed geology of these rocks as they occur in the Interbasaltic Horizon of Co. Antrim. The present work deals with the nature of the chemical changes concerned in the process of lateritization and of the composition of the Interbasaltic lateritic rocks themselves. The latter were formed during a prolonged pause in the Tertiary volcanic activity responsible for the Antrim basalts. At an early stage in this Interbasaltic period there was a brief recrudescence of activity characterized by the eruption of highly silicic lavas. Intense erosion followed, with removal of most of the rhyolites and complementary deposition of thin sediments largely composed of rhyolitic debris. Towards the end of the lateritization period a thin coal seam was formed from the vegetation that flourished over the area. An interesting note records that Dr. J. B. Simpson finds the floral remains from a coal associated with bauxite near Portrush to be of essentially the same age as the corresponding horizon in Mull, to which he is inclined to ascribe a late Miocene or early Pliocene age. This is so much later than has hitherto been thought probable that the publication of Dr. Simpson's palaeobotanical researches will be eagerly awaited. The Interbasaltic period was terminated by the outpouring of the Giant's Causeway and later basaltic flows. At the same time, or later, basaltic dykes were intruded, and these, cutting through the lateritic rocks, affected marked metamorphic changes.

The Irish laterites and bauxites were formed in two distinct stages: (a) alteration to lithomarge, consisting of kaolinite or halloysite; and (b) lateritization, involving further desilication with formation of gibbsite ($\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$) together with oxides of iron and titanium. With long-continued operation of the process the iron oxides tend to concentrate towards the surface, forming an increasingly ferruginous laterite and eventually a workable iron ore, overlying a layer of richly aluminous laterite or bauxite. In Ireland, unfortunately, neither complete desilication of lithomarge nor clean separation of aluminous from ferruginous laterite has occurred over more than

limited areas. The prevailing types are lateritic lithomarges and ferruginous or siliceous laterites. It appears that quartz, originally present in a parental rock, may persist unchanged; the possibility of, and the conditions governing, the total elimination of quartz still require further investigation. A chemical method, devised and described by Mr. O. O. Harvey, is given for the quantitative determination of quartz in the presence of combined silica.

Much valuable information has been obtained from the application of the X-ray diffraction technique to selected specimens. The chief minerals recognized include meta-halloysite and kaolinite; gibbsite and boehmite (but not diasporite); hematite, goethite and magnetite; and anatase. Chamosite has been found in certain parts of the laterite horizon which exhibit a greenish tinge. Since the formation of chamosite requires reducing conditions, its occurrence implies that it is a secondary mineral relative to the lateritic minerals with which it is now associated. The abundance and distribution of various minor elements has been determined by Dr. S. Landergrén, whose results demonstrate enrichment of the laterites in vanadium and probably in chromium.

Discussing the geological conditions influencing the formation of the several hydrated oxides of aluminium, Mr. Eyles points out that the widespread distribution and prevalence of the gibbsite type of bauxite suggests that this is the variety normally developed. He presents detailed evidence to justify the tentative conclusions: "(i) that the formation of monohydrates in large amounts results from a change of geological environment superimposed on gibberitic laterites after the formation of the latter; (ii) that increased pressure resulting from subsidence, or dynamic action, or both, and not rise in temperature alone, may often be the main, though possibly not the sole, factor causing the large-scale development of monohydrates of alumina; (iii) that while igneous intrusions or lava flows alone may cause localized development of boehmite in laterite deposits, pressure is probably essential for the formation of diasporite in large quantities".

Mr. Eyles and his colleagues have made this a model investigation of its kind. It is to be hoped that their lead will be followed, so that it may no longer be necessary to direct attention to the fact that "descriptions of foreign laterite are not always sufficiently complete to permit generalizations to be drawn from the facts presented".

A. HOLMES

CARNEGIE TRUST FOR THE UNIVERSITIES OF SCOTLAND

ANNUAL REPORT FOR 1952-53

THE fifty-second annual report of the Carnegie Trust for the Universities of Scotland, covering the academic year 1952-53*, deals with a period before the most recent regulations of the Scottish Education Department for the award of bursaries by Scottish education authorities became effective so far as the Trust is concerned; but the executive committee to the trustees points out that the amounts awarded in terms of these regulations constitute a

* The Composition and Origin of the Antrim Laterites and Bauxites. By V. A. Eyles, with mineral determinations by X-ray methods by F. A. Bannister (British Museum, Natural History) and G. W. Bendley and J. Goodyear (University of Leeds). (Memoir of the Geological Survey of Northern Ireland.) Pp. vi+90. (Belfast: H.M. Stationery Office, 1953.) 12s. 6d.

* The Carnegie Trust for the Universities of Scotland. Fifty-second Annual Report (for the Year 1952-53). Submitted by the Executive Committee to the Trustees on 22nd February, 1954. Pp. iv+72. (Edinburgh: T. and A. Constable, Ltd., 1954.)

difficult problem for the Trust. Applications are now being received from students whose parents or guardians in the earlier years of its history would not have had recourse to the Trust, and each application presents a case in itself. Moreover, since individual education authorities frequently withdraw the bursary for a further year if the student fails to pass all his degree examinations at the appropriate time, the student often applies to the Trust for assistance towards his class fees, and the whole circumstances attendant on failure must be reviewed. While, for the time being, the executive committee has awarded class fees when there seemed to be a reasonable prospect of the student's being able to reinstate himself, it shares with the education authorities considerable anxiety as to the total effect of these bursary regulations emanating from the Education (Scotland) Act, 1946. The 1,301 students assisted during 1952-53 received £20,003 compared with £15,089 to 1,028 students during 1951-52; repayments by former beneficiaries were £2,062 from 34 beneficiaries, compared with £1,985 during 1951-52.

The amount devoted to the research scheme during 1952-53 was £32,646, or some £5,000 less than during 1951-52, and scholarship awards were made more rigorously. The special fund for assisting the publication of work embodying original research now stands at £9,059. Both the scheme recently introduced to give opportunity for senior members of university staffs to go abroad for periods of research up to one year, and the block grants to the four universities to enable members of their staff to use their vacations fruitfully in research, whether at home or on the Continent of Europe, are regarded as successful. Grants were also made to Scottish learned societies, to "A Dictionary of the Older Scottish Tongue", "The Scottish National Dictionary", "The Scottish Historical Review", and, through the universities, to "The Third Statistical Account". Appended to the report are lists of publications by fellows, scholars and recipients of grants received since September 1952, of recipients of grants and of assisted papers, and a résumé of reports upon the work of investigators under the research scheme.

In the mathematical, physical and engineering section, Sir Richard Southwell comments particularly on Dr. W. Paul's work on the effect of high pressures on the properties of semiconductors, Dr. A. G. Mackie's work on the hodograph method for the problem of compressible-flow around sharp corners, and Mr. P. B. MacFarlane's study of Pleistocene changes of sea-level. In medicine, I. A. Macpherson has made marked progress in studying haemagglutination by viruses and its inhibition by bacterial polysaccharides, and J. Grieve on the treatment of experimental peritonitis in rats with phthalylsulphathiazole.

In chemistry, Dr. T. R. R. McDonald's work on the crystal structure of ammonium bifluoride promises to yield valuable information about the nature of the hydrogen bond. Dr. A. R. M. Gibb has made excellent progress in synthesizing tropolone derivatives in his work on the preparation of compounds, structurally related to colchicine, which might possess its antimitotic effects but not its poisonous properties; Miss Evelyn E. B. Smith has discovered several new reactions involving uridine pyrophosphate derivatives, and her investigation of the enzymic mechanisms concerned has now gained her a Beit fellowship for medical research to study enzymic mechanisms at the University of Glasgow. Other investigations in chemistry noted in the

advisers' report are those of W. J. Bremner on the flow of gases through a porous plug; A. J. Sorrie on the synthesis of benzotropolone, in which he has discovered the effectiveness as a condensing agent of a fused mixture of sodium chloride and aluminium chloride; R. Logan on the use of radioactive phosphorus to find the rates at which phosphorus is taken up into the different nucleotides in the constituents of the cytoplasm of the liver cells in the domestic fowl; and G. A. J. Goodlad on the enzymes found in the liver which effect transformations of sugar phosphates.

In biology, Dr. J. W. H. Lawson has commenced a lengthy investigation on the systematics and biology of aquatic species of the Chironomids, G. D. Scott is investigating the ecology and physiology of lichens, Miss Janet E. O. Towers has studied the chromosomes in amphibian oocytes, D. C. W. Smith has done much work on the endocrine control of osmoregulation in Salmonids and E. A. Salzen has made a good beginning in a study of the rate of growth of insect embryos at different stages of development.

AVERAGES OF BRIGHT SUNSHINE AND TEMPERATURE FOR GREAT BRITAIN AND NORTHERN IRELAND

THE Meteorological Office has recently published two pamphlets giving, respectively, averages of sunshine and of temperature for Great Britain and Northern Ireland during the period 1921-50*. The sunshine measurements are all made by the Campbell-Stokes instrument, which does not record sunshine below a certain level of intensity, so that the averages refer to 'bright' sunshine. The pamphlet gives average annual and monthly totals and daily means for the months and the year for 187 stations distributed all over Great Britain and Northern Ireland. The records show that, on the average, the Isle of Wight and the Sussex coast are the sunniest areas, with an annual average of more than five hours a day. This area is sunniest in summer as well as in winter. The least sunny rural areas are north and mountainous districts of Scotland, in which some stations average a little less than three hours a day. Sandown had most sunshine in the period with an annual average of 1,840 hr., but was very closely followed by Worthing, Ventnor and Eastbourne. The publication contains useful material for the study of the loss of sunshine in the centre of great cities. It is noteworthy that Bunhill Row in the City of London averaged 3.45 hr. a day against the 4 hr. of Kew and Hampstead, and Manchester (Whitworth Park) 2.9 hr. against 4.1 hr. at Hoylake and Southport. The loss of sunshine in cities is greatest, both absolutely and relatively, in winter. The publication includes a table comparing the averages for 1901-30, 1906-35 and 1921-50 at seven well-distributed stations. The mean daily sunshine at Birmingham, 3.56 hr., was the same in 1921-50 as 1901-30, but the other stations show reductions of up to 0.09 hr.

* Air Ministry: Meteorological Office. *Averages of Temperature for Great Britain and Northern Ireland, 1921-50* (M.O. 571); pp. 11+36; 2s. *Averages of Bright Sunshine for Great Britain and Northern Ireland, 1921-50* (M.O. 572); pp. 11+33; 2s. (London: H.M.S.O., 1953.)

The pamphlet on temperature contains monthly and annual averages of maximum, minimum and mean, half (maximum plus minimum), temperatures in degrees Fahrenheit. The lowest annual average temperature recorded, 43.5° at Braemar (1,111 ft.), is 9 deg. below the highest, 52.5° at Scilly. The mean July maximum ranges from 73.4° in London to 57.8° at Lerwick. In January Cornwall has the highest maxima, with means of 48–50°, but over most of England and Scotland mean maxima are between 42 and 45°. It is necessary to go to stations at heights of more than 500 ft. to find mean January maxima below 40° (Braemar 39.4°) or mean January minima below freezing point (Balmoral 28.4°). Comparisons between the monthly and annual averages for the periods 1901–30, 1906–35 and 1921–50 are given for seven stations. At all the stations there was an increase in mean annual temperature of about 0.5 deg. from the first to the third period. The increase, at about 1 deg., was most marked in summer. Spring and autumn also were slightly warmer; but winter was slightly colder. It is particularly interesting that the difference between the mean annual temperature of the two periods should be so uniform over the whole country.

CORPUSCULAR ECLIPSE IN THE F_2 -LAYER AND ITS ASSOCIATION WITH SOLAR FLARES AND M-REGIONS

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THE fact that certain intense magnetic storms tend to occur about a day after the visual observation of eruptions (flares) on the sun has led to the belief that these storms are caused by the arrival of fast beams of corpuscles (which taken as a whole are neutral) from the sun having velocities of the order of 1,000–2,000 km./sec. The most direct evidence of the presence of fast incoming particles has been provided by the observations of Mainel¹ during an intense auroral display on August 18–20, 1950. By pointing his spectrograph towards the magnetic zenith and comparing the result with that obtained with the spectrograph towards the magnetic horizon, he found that the $H\alpha$ line had a violet shift (λ 71 Å. for the wing and λ 10 Å. for the maximum) which corresponded to a velocity of 3,200 km./sec. for the incoming protons.

In the ionospheric regions the effect of the solar flares is manifested in the form of Dellinger type of fade-outs, which synchronize with the time of the flares, indicating that it is the ultra-violet light emitted from the solar flare which is responsible for the effect. S. N. Mitra and Mazumdar² found from an analysis of Delhi records for the years 1946–49 that a number of the flares were followed 20–40 hr. later by further fade-outs. For example, out of thirteen flares of type 3 and 3+, four were accompanied by simultaneous fade-outs, and in three cases, fade-outs occurred 20–40 hr. later. The other six

flares were not, however, attended by simultaneous or later fade-outs. During the same period, twenty-three flares of type 2 had been reported, and they found one of these flares to be associated with simultaneous fade-out; in two cases the fade-outs were delayed by 20–40 hr. and the rest of the flares were apparently ineffective in causing fade-out.

The delayed fade-outs which are found to set in about one or two days after the visual observation of a solar flare may be attributed to the action of fast neutral beams of corpuscles originating from the flares, and speeding towards the earth with velocities of the order of 1,600–800 km./sec. Chapman³ pointed out that if a portion of the ionization in the ionospheric layers is caused by the impact of a solar corpuscular stream, an effect should be observable during solar eclipses. He showed that a corpuscular eclipse should occur about two hours earlier than the optical eclipse if the velocity of the corpuscles is taken to be 1,600 km./sec. Later, Chapman⁴ gave reasons why the ideal conditions for the corpuscular effect to be recorded are not likely to be present every time. We wish to point out that there are a number of eclipse observations on record where the investigators have directed attention to the presence of a corpuscular eclipse in accordance with Chapman's ideas: for example, those of October 1, 1940, at Queenstown by Pierce⁵; January 25, 1944, at Huancayo by Ledig *et al.*⁶; February 25, 1952, at Delhi by S. N. Mitra⁷, and on the same occasion at Banaras by S. S. Banerjee *et al.*⁸. In Fig. 1, a few examples have been reproduced with the values of f_oF_2 prepared from the observations, plotted against L.M.T. A corpuscular effect is clearly seen in Figs. 1 (b) and 1 (c) about 2–2½ hr. before the optical eclipse.

Source of Corpuscular Streams

The presence of the corpuscular eclipse about two hours before the optical eclipse provides evidence that fast corpuscles are coming with velocities of the order of 1,600 km./sec.; but it does not indicate whether these corpuscles are associated with solar flares or other disturbed regions of the sun. Judging from the high percentage of magnetic storms and simultaneous radio fade-outs which do not seem to be associated with any observed flare at all, it appears that there may be some other agency on the sun which emits the corpuscles in question, for S. N. Mitra and Mazumdar² found that out of 122 fade-outs recorded during the years 1946–49 at Delhi, 81.2 per cent apparently had no connexion with any flare at all. This encourages us to link up the corpuscular radio fade-outs with *M*-region activity.

It is well known that some of the moderate magnetic storms which seem to have no connexion with visible solar flares have a tendency to recur every 27 days with the synodic rotation of the sun. These magnetic storms, also known as *M*-storms, have been attributed by Bartels⁹ to unidentified active regions of the sun which he calls *M*-regions. The physical nature of the *M*-regions has not yet been established with certainty, nor have the *M*-regions been yet clearly associated with any prominent physical feature on the sun. Waldmeier¹⁰ originated the idea that the intensity of the *O*-regions, that is, the coronal regions of bright line emission (particularly λ 5303), could be used as an index of the activity of *M*-regions. The analysis of Shapley and Roberts¹¹ for the years 1942–44 during a period of sunspot minimum indicated that the appearance of

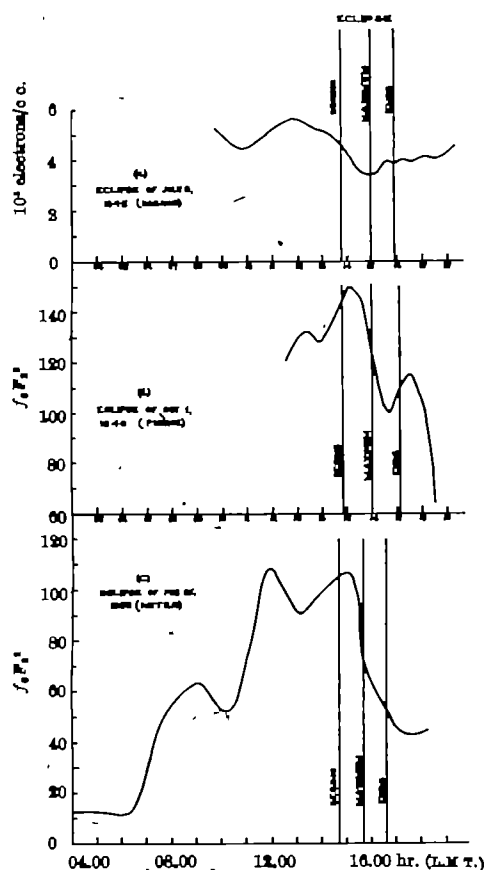


Fig. 1. Variation of the F_2 -layer ion density during solar eclipses

a bright coronal patch (C -region) at the east limb of the sun was followed three to four days later by the onset of M -storms. Trotter and Roberts¹³ and Müller¹² confirmed the ideas of Shapley and Roberts from the records of 1952 (which is close to the next period of sunspot minimum) and also estimated the lag to be about three days. Allen¹⁴ has associated the onset of M -storms with the central meridian passage of coronal streamers, and is of the opinion that the corpuscles responsible for the M -storms take about one day for intense storms and longer for moderate storms to reach the earth. Von Klüber¹⁵ supported Allen's views from his observation of the solar corona during the total solar eclipse on February 25, 1952, at Khartoum, when a long and intense streamer was seen at the east limb of the sun. Waldmeier¹⁶ suggested from a scrutiny of the 1939-40 observations that the M -storms occurred about one day after the central meridian passage of the bright coronal patches. Later he¹⁶ expressed the view that the bright coronal regions were only partly responsible for M -region activity, which he believed on further consideration to originate in the neighbourhood of large sunspot groups after the disappearance of the spots. He also directed attention to the fact that as long as new spot groups did not appear, the areas vacated by spots were associated with stationary prominences and coronal streamers. Maxwell¹⁷ cited an example when M -region activity developed 27 days after an intense radio emission, which was associated with a decaying sunspot group.

The lesson of these observations appears to be that the mystery of the M -regions on the sun is still

unsolved. But they bring out clearly the inference that the M -storms develop as a result of a corpuscular effect, the corpuscles taking, according to different views, about one to three days to reach the earth. (Wulf and Nicholson¹⁸ have, however, suggested that the M -storms are caused by intense ultra-violet light from areas of bright calcium and hydrogen flocculi when appearing at the east limb of the sun.) The corresponding velocities would be of the order of 1,600-600 km./sec. The strength of the storm would obviously be governed by the speed and intensity of the corpuscular stream.

The moderate M -storms have been known to persist for months through several rotations of the sun, indicating apparently that the slower corpuscles with velocities of 800-600 km./sec. are predominantly emitted by the M -regions. These slower particle streams, if they exist, should give rise to a similar corpuscular eclipse in the variation of f_2P_2 , about four to six hours earlier than the corresponding optical eclipse, provided such particles are able to penetrate the F_2 -layer. Fortunately, the analysis of a number of ionospheric data secured by different observers at widely different stations, and quite independent of each other, confirms this view. A glance at Figs. 1 (a) and 1 (c) quoted above shows that at about 5 hr. before the time of maximum of optical eclipse there was a significant drop in the curves, which could be interpreted as a corpuscular eclipse due to corpuscles having velocity of the order of 640 km./sec. Smith-Rose¹⁹ has also reported that the observations carried out near Moscow during the eclipse of July 9, 1945, indicated the presence of a corpuscular eclipse corresponding to velocities of the order of 450-600 km./sec. Only a few cases were available for which the expected time of occurrence of corpuscular eclipse happened to lie within the daylight hours. It was also found that in a good many cases the observations had not been extended to cover the period when a corpuscular eclipse could be detected; such an effect at about five to six hours before the time of optical eclipse was not expected. But the records of Harang²⁰ (Fig. 1a), S. N. Mitra⁷ (Fig. 1c) and the report of Smith-Rose provide positive evidence that the slower corpuscles responsible for the effect take about three days to travel from the sun to the earth.

A feature of considerable interest is brought out in the observations of S. N. Mitra⁷ (Fig. 1c), which shows the presence of two corpuscular eclipses, at about 2½ hr. and 5 hr. respectively before the time of maximum of the optical eclipse on February 25, 1952. This result indicates that there were two predominating groups of corpuscles on that occasion, one of which had a velocity of about 1,300 km./sec. and started one day earlier on the sun, and the other group a velocity of about 640 km./sec. and started about 2½ days earlier on the sun. S. S. Banerjee *et al.*⁸ obtained the effect due to a corpuscular eclipse at about 2½ hr. earlier than the optical eclipse on the same occasion at Banaras; his records do not extend sufficiently to show the other corpuscular eclipse. It may be mentioned in this connexion that according to the observations of the Solar Observatory, Kodaikanal, there were no solar flares during February 1952, and therefore neither of the corpuscular eclipses could be associated with any flare activity. But marked magnetic and ionospheric disturbances prevailed on February 23, 24 and 25, 1952, no doubt under the influence of corpuscular streams associated with M -regions.

It may be noted that some of the velocities given above are less than the critical velocity of 616 km./sec. required for escape of a particle from the sun's surface (for example, 600 km./sec. required for a three-hour delay); but the reason may be that particles emitted with such velocities may describe very elongated ellipses, which may carry them beyond the neutral point of gravitational attraction between the sun and the earth and thus may enable them to enter the earth's domain. For a velocity slightly smaller than the critical velocity, the path may be widely different from a straight one, and thus it may be greater than the actual sun-earth distance. This may cause considerable reduction of the velocity. In conclusion, the suggestion is made that in future eclipse expeditions the observation of the F_2 -layer of the ionosphere should be started at least seven hours earlier than the moment of totality.

Our thanks are due to Prof. M. N. Saha for his interest.

[Jan. 4.]

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VASCULAR PLANTS COMMON TO THE ARCTIC AND THE BRITISH ISLES

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SOME fourteen years ago I published^{1,2} an attempted analysis of "Arctic Plants in the British Isles", which was based on one hand on the existing, but partly outdated, British floras and, on the other, on such vascular plants as were known to occur north of lat. 75° N. Sixty-two species or geographical varieties (subspecies) in the native British flora as then known were recognized as being undoubtedly arctic in their affinities, in the absence of proper criteria for a more adequate computation. Of these, no less than forty were characteristic of open soil or rock crevices, seven more were plants of sea-shores or lake margins (making a total of forty-seven characteristic of open habitats), a further eight were characteristic of other habitats but frequently found in open areas in both regions (making a total of fifty-five which are to be found in open habitats), and only the remaining seven of the sixty-two were

marsh or 'heath' plants usually confined to these or other closed communities. Thus the great majority (75.8 per cent) grew chiefly in the absence of competition and no less than 88.7 per cent are frequently found in at least ecologically 'open' situations both in the north and in the south, while some of the remainder may occasionally be encountered in such habitats in the Arctic.

Apart from more floristic exploration in the British Isles and the Arctic, in both of which a great deal has been accomplished since 1939, the main needs before a more worthy analysis of the situation could be made were (1) a proper or at least 'working' delimitation of the Arctic, (2) a modern flora of the Arctic based on such a delimitation, and (3) an up-to-date British flora. With (1) I have long been concerned and, although far from satisfied with the result, have latterly ventured to publish my suggestions (by special request, "although suspecting that in time increased knowledge of local flora, precipitation, total heat, and the incidence of frosts as well as the combination of wind and cold known as 'windchill' will add solidity to the picture, and knowing full well that increased local knowledge will add to its precision"). The accompanying map indicates the southern boundary of the Arctic and proposed subdivision of the latter for phytogeographical citation into ten sectors (the longitudinal subdivision into low-, middle-, and high-arctic zones cannot yet be indicated). At (2) I have been working off and on since 1940, with the result that I now have virtually completed a "Circumpolar Arctic Flora" (to be published by the Oxford University Press) of all the families, genera and species of vascular plants that are known to reach the Arctic as delimited in (1): a proper critical treatment involving lower taxa will have to await the availability of far more Siberian material than is at present open to the Western world. Prerequisite (3) has recently been covered by the publication of Clapham, Tutin and Warburg's welcome "Flora of the British Isles"⁴, to which should already be added further pertinent species⁵. Consequently, a far more adequately based analysis of the species of vascular plants common to the Arctic and the British Isles can now be made.

Taking in general a rather broad, 'conservative' view of specific limits, I have computed that 874 species of vascular plants are so far known to inhabit the Arctic (according to my largely *ad hoc* delimitation). Of these, 833 are native and 41 appear to be established aliens. Of the latter, 33 occur as natives in the British Isles according to the latest reckoning⁶, as does probably another not recognized therein, 3 more occur in the British Isles as aliens, while at least 3 native arctic species seem to be well-established introductions in Britain. There appears to be only a single recognized arctic alien that is unknown in Britain in anything approaching a wild state, though probably others will be recognized when the northern parts of Siberia, particularly, become better known to Western botanists.

Of the 833 species of native arctic vascular plants at present recognized, no less than 267 occur in the native British flora, in which they consequently form a very substantial 'element' and, in addition, two more used to occur but are now apparently extinct. To arrive at the main figure, occasional compressions have had to be made to get over differences of opinion as to specific limits, especially where insufficient herbarium material was available for practical

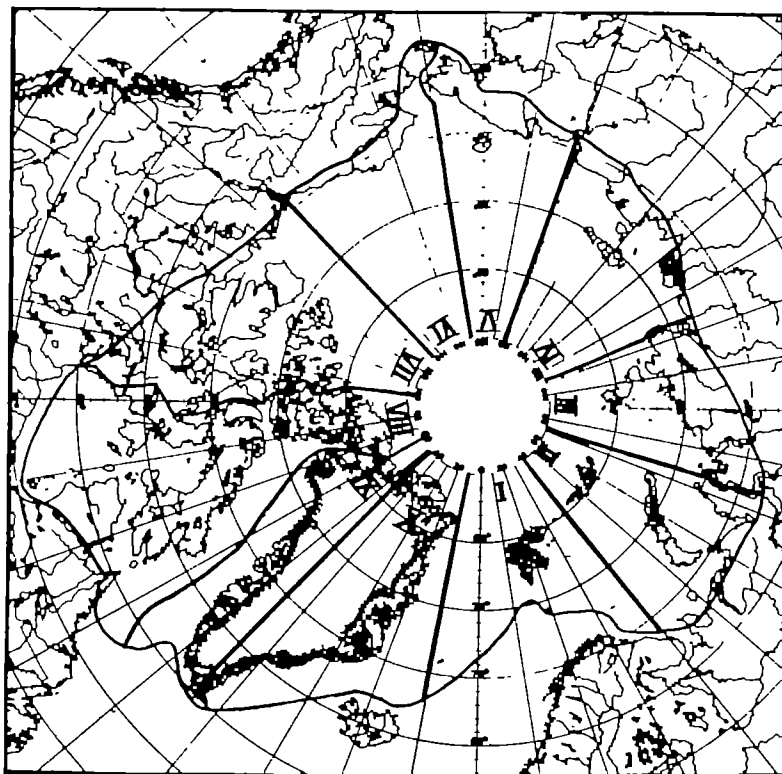


Fig. 1. North polar regions, showing proposed delimitation and subdivision of the Arctic

clarification; the result when we add introduced plants is that 309, or more than 35 per cent, of the species of vascular plants so far known to inhabit the Arctic occur also in the British Isles. This excludes supposedly extinct species but includes aliens; even if the latter, too, are excluded, just over 32 per cent of native arctic vascular species are known in the present-day native British flora. Of the remainder, stimulated by news of several recent discoveries, I have selected the fifty which seem to me most likely to be found in the British Isles in the future*. The majority of these are plants of open soil or other habitats where there is little or no competition with other species, and almost all are able to grow in such situations in the Arctic.

It remains to make an analysis, primarily along the lines attempted previously from much less adequate data¹, of the 309 species of vascular plants at present accepted as common to the Arctic and the British Isles. Representing introduced species are all those supposedly transported by man to the regions concerned—whether by the Norsemen many centuries ago or by others quite recently—so long as they appear to have become established in a more or less wild state, and whether introduced to the Arctic or Britain or both. In cases of serious doubt, as, for example, where a normally introduced species could, so far as the habitat or collection-label indicated (or failed to indicate), be considered as perhaps locally native, it has been counted as introduced, so as not to weigh unfairly on the side of the natives. But when a normally introduced species appears to be native in even one place in the Arctic it has been counted as native therein.

The following categories and representations were recognized in this new analysis.

(1) Plants commonly of open soil or rocky, etc., habitats with little or no competition (although humus may be plentiful). (a) Found in all three latitudinal arctic zones and of wide distribution meridionally in the Arctic (occurring in at least 5 of the 10 sectors indicated in the map). Total 47 (all native). (b) Occurring northward at least to the middle-arctic zone, and found in at least 3 sectors (cf. map). Total 23 (all native). (c) Limited to the low-arctic zone or otherwise of restricted distribution in the Arctic. Total 59 (including 25 introductions, namely, 19 introduced in the Arctic, 1 in Britain, and 5 in both).

(2) Plants of sea-shores or lake, etc., margins (including aquatics) with little or no competition. Total 43 (all native).

(3) Plants to be found in open areas but characteristic of closed habitats. Total 80 (including 15 introductions, namely, 13 introduced in the Arctic, 1 in Britain, and 1 in both).

(4) Plants usually restricted to closed habitats. Total 48 (including 2 introductions,

namely, 1 introduced in Britain and 1 in the Arctic).

It is thus seen that, of the species of vascular plants common to the Arctic and the British Isles, a total of 172 or 55.66 per cent are to at least a considerable extent 'open soil' plants or their competition-ecology equivalents, and a further 89 (making a total of 84.46 per cent) are fairly frequently to be found growing in such circumstances. Although these percentages are lower than those formerly computed from a much more limited flora²—as was to be expected particularly in view of the preponderance of open habitats in the Far North—the latter one is only slightly lower. This confirms the earlier suggestion that the majority of British vascular plants which reach high latitudes grow largely where there is little or no competition, while the vast majority of them are fairly frequently to be found in such circumstances—in the south where closed vegetation is the general rule as well as in the Arctic where it is not. Even of the 48 remaining species normally restricted to heathy, marshy, or other closed habitats, a considerable proportion are occasionally to be seen growing in 'open' areas.

Further notes and details will shortly be published in *Watsonia*—including, in line with the policy followed on the previous occasion, lists of the species of plants in each of the above categories.

¹ 'The Arctic Element in the British Flora' (abstract), *Proc. Linn. Soc. London*, Session 151, 151 (1939).

² *Nature*, 144, 363 (1939); *J. Bot.*, 77, 270 (1939).

³ *J. Ecol.*, 30, 308 (1942).

⁴ 'Flora of the British Isles' (Cambridge University Press, 1953).

⁵ *Nature*, 168, 934 (1951); 171, 333 (1953).

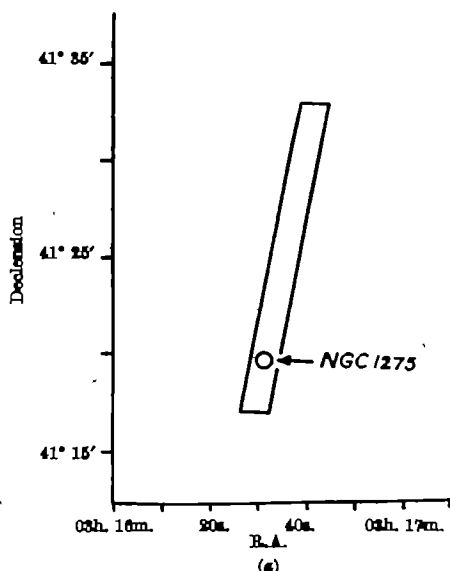
⁶ *Watsonia*, 3, 24 (1953).

LETTERS TO THE EDITORS

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Radio Emission from the Perseus Cluster

A RADIO source the position of which coincides closely with the cluster of extragalactic nebulae in the constellation of Perseus has been observed by Ryle, Smith and Elsmore¹, by Mills² and by Hanbury Brown and Hazard³. The last-named authors have



Observations with the new Cambridge radio telescope⁴ have been made on a wave-length of 3.7 m. using interferometer apertures of 14 λ and 157 λ. On the assumption that the radio emission was produced by the integrated effect of all the component members of the cluster, the angular distribution of intensity was calculated from optical counts of nebulae in the cluster. For a source having this distribution, the apparent intensity which would be observed with an aperture of 157 λ would be 7 per cent of that obtained with a 14 λ aperture. If, on the other hand, the radiation originated in NGC 1275,

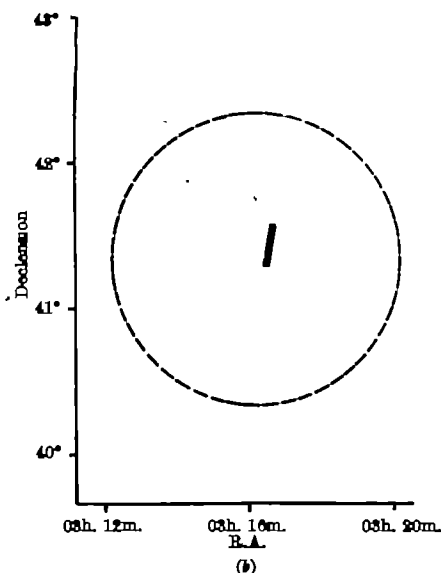


Figure showing the position and limits of error of the radio source obtained with the 157 λ aperture in relation to (a) NGC 1275 and (b) the Perseus cluster as a whole. (Epoch 1950.0)

suggested that the observed radio emission is to be associated with the cluster as a whole, and they have pointed out that on this hypothesis there is an important discrepancy between the average radio emission of the individual galaxies of the cluster and that of nearby galaxies. Baade and Minkowski⁵, on the other hand, have suggested that the radio source should be identified with NGC 1275, one of the members of the cluster. This nebula, like that associated with the intense radio source in Cygnus, is probably another example of two galaxies in collision; the optical spectrum contains lines of high excitation and the structure suggests that a collision has taken place between an elliptical and a spiral nebula.

Experiments to decide which of these two hypotheses is correct are important since they might provide information concerning the radio emission accompanying a collision of this type; alternatively, if the radiation were found to originate in the cluster as a whole, it would have importance in connexion with the relation between the visual and radio magnitudes of extragalactic nebulae.

The angular diameter of the whole visible cluster is approximately 2°, whereas that of NGC 1275 is only 0.7'. Measurements of the angular diameter of the radio source should therefore be important in distinguishing between the two possible interpretations. If the source proved to have small angular size, its association with NGC 1275 might be confirmed by accurate positional measurements.

the intensities observed with the two apertures would be the same to within 1 per cent. The results obtained are summarized as follows:

Aerial spacing	Apparent intensity
14 λ	$16 \times 10^{-26} \text{ W.m.}^{-2} (\text{c/s.})^{-1}$
157 λ	$12 \times 10^{-26} \text{ W.m.}^{-2} (\text{c/s.})^{-1}$

These results show that about 75 per cent of the radiation originates in a source of small angular size; the close agreement between the position obtained with the high resolving power and that of NGC 1275 shown in the figure provides strong confirmation of the identification made by Baade and Minkowski.

The intensity produced by the remaining galaxies of the cluster is approximately $4 \times 10^{-26} \text{ W.m.}^{-2} (\text{c/s.})^{-1}$; this is in good agreement with that derived on the assumption that there is a constant ratio between the optical and radio emission of extragalactic nebulae.

These observations were undertaken as part of a programme of research supported in the Cavendish Laboratory by the Department of Scientific and Industrial Research, to which one of us (J. E. B.) is indebted for a maintenance allowance.

J. E. BALDWIN
B. ELSMORE

Cavendish Laboratory,
Cambridge. March 6.

¹ Ryle, M., Smith, F. G., and Elsmore, B., *Mon. Not. Roy. Astro. Soc.*, 110, 508 (1950).

² Mills, B. Y., *Aust. J. Sci. Res.*, A, 5, 266 (1952).

³ Brown, R., Hanbury, and Hazard, C., *Phil. Mag.*, 43, 187 (1953).

⁴ Baade, W., and Minkowski, R., *Astrophys. J.* (in the press).

⁵ Ryle, M., and Hewish, A. (in preparation).

Intensities of Discrete Radio Sources in Cygnus and Cassiopeia at 22.6 Mc/s.

It is important both for the understanding of the nature of the localized radio sources and the determination of interstellar radio absorption to extend the measurement of the spectra of the sources to as low radio-frequencies as possible. Ionospheric transmission sets a limit, but by choosing frequencies not too close to the critical frequency, and restricting observations to days of low ionospheric disturbance, reasonably accurate measurements may be obtained. In this way, we have recently made measurements at a frequency of 22.6 Mc/s. ($\lambda = 13.3$ m.) by means of an interferometer consisting of two aerials spaced in the east-west direction at 20 wave-lengths apart, thus producing lobes in the aerial pattern at intervals of about 3° . Each aerial consists of an array of six full-wave dipoles giving a vertically directed beam of width $\pm 22^\circ$ and $\pm 9^\circ$ in the north-south and east-west directions respectively. The recording apparatus is a simplified form of the type described by Machin, Ryle and Vonberg¹, whereby the receiver is continually switched to a standard noise diode source which is automatically adjusted by a servo-mechanism to equalize the received radiation.

Recordings of the intensity of the discrete radio sources in Cygnus and Cassiopeia were made between June and November 1953. Ionospheric conditions frequently caused violent amplitude fluctuations, and at times there were not only severe decreases of intensity but also increases from the undisturbed value by a factor of two or three. In determining the absolute intensity of the sources, only those records were used where the fluctuations were of negligible amplitude, and this occurred on more than thirty days during the period of observation. The absolute intensities of Cassiopeia and Cygnus were respectively 9.4×10^{-23} and 4.6×10^{-23} watts m.⁻² (c/s.)⁻¹ with an r.m.s. error of less than 20 per cent, excluding a possible systematic error in aerial gain. If the sizes of the sources are taken to be those determined by Hanbury Brown, Jennison and Das Gupta^{2,3} at 125 Mc/s., the brightness temperature of Cassiopeia at 22.6 Mc/s. is about 6×10^6 deg. K. and that of Cygnus about 3×10^6 deg. K.; it is possible that the sources may be more extensive at the lower frequency and the brightness temperature correspondingly reduced.

The values we have obtained at 22.6 Mc/s. have been plotted in Fig. 1, together with the intensities at higher frequencies published by Stanley and Slee⁴, Ryle, Smith and Elmore⁵, Hanbury Brown and Hazard⁶, and Mills⁷, and the results indicate that the intensity continues to increase as the frequency is decreased. The spectrum of Cassiopeia follows a law of intensity proportional to (frequency)^{-1.2}. The spectrum of Cygnus, on the other hand, closely follows the same law as Cassiopeia at higher frequencies but, at low frequency, appears to deviate by about 20 per cent. The accuracy of the measurements of absolute intensity are probably only of this order, but the reality of this deviation can be tested by comparing the more accurate relative values of the intensities of the two sources obtained by those observers who, on their particular frequency of observation, have used their apparatus to measure both sources. These ratios are shown in Table 1, which again indicates that, although at the higher frequencies the ratios of the intensities of Cygnus and Cassiopeia are equal, at the lowest frequency

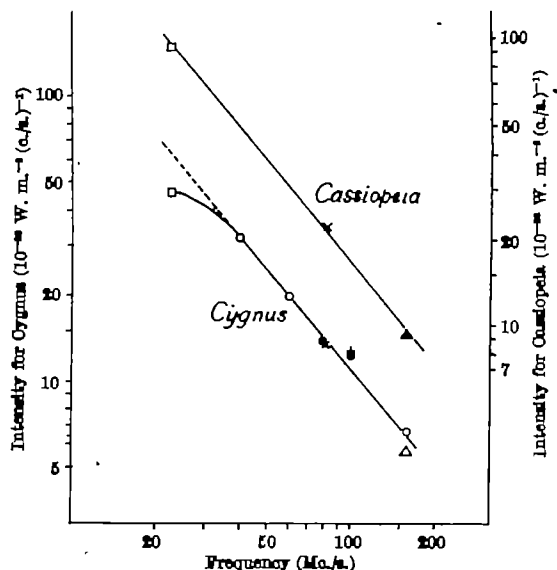


Fig. 1. Spectra of the discrete sources in Cygnus and Cassiopeia. The straight lines represent the law of intensity $\propto$ (frequency)^{-1.2}. $\circ$, Stanley and Slee (ref. 4) (intensities tabulated by Piddington and Minnett, ref. 13, are plotted); $\times$, Ryle, Smith and Elmore (ref. 5); Δ , Hanbury Brown and Hazard (ref. 6); $+$, Mills (ref. 7); $\square$, present results.

the intensity of Cygnus is reduced by about 20 per cent in comparison with Cassiopeia.

Baade and Minkowski⁸ have recently associated the source in Cassiopeia with unusual nebulous filaments of gas at a range not greater than 500 parsecs; the source in Cygnus appears to be due to the collision of two nebulae and is at a range of 34 megaparsecs on the old distance scale. The source in Cassiopeia is a member of the galactic system, and although close to the galactic equator, it is a near source which shows no evidence of visual obscuration. The Cygnus source is extra-galactic and situated at low galactic latitude near the edge of the 'zone of avoidance', the region in which the numbers of observed extra-galactic nebulae are reduced by visual obscuration. Observations of the 21-cm. line emission^{9,11} also indicate the occurrence of a considerable depth of hydrogen in the ground-state in this direction. If the interstellar gas is appreciably ionized, absorption may be expected at the lower frequencies. As the high-frequency spectra of the two radio sources are similar, and both seem to have their origin in low-density clouds with high internal velocities, it is possible that their emission spectra may be fundamentally the same but that the intensity of Cygnus at 22.6 Mc/s. is reduced by interstellar absorption. Alternatively, part of, or all, the reduction may be characteristic of the spectrum at the source. As it appears unlikely that the slope of the frequency spectrum would increase in magnitude,

Table 1. INTENSITIES OF THE RADIO SOURCES IN CYGNUS AND CASSIOPEIA

Observer	Frequency (Mc/s.)	Intensity in units of 10^{-23} watts m. ⁻² (c/s.) ⁻¹		Ratio of Cygnus/Cassiopeia
		Cassiopeia	Cygnus	
Hanbury Brown and Hazard (ref. 6)	158.5	9.25	5.7	0.62
Ryle, Smith and Elmore (ref. 5)	81.5	23.0	13.5	0.61
Present results	22.6	9.4	4.6	0.49

the 20 per cent intensity reduction of Cygnus is an upper limit to the galactic absorption. The integrated product of path-length times absorption coefficient is consequently not more than 0.2; and as the galactic latitude of Cygnus is 4.9° , the comparatively low absorption is a further confirmation of the findings of Scheuer and Ryle¹² that, if appreciable ionized interstellar gas is present in the galaxy, it is confined within narrow limits to the galactic equator.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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V. A. HUGHES

Radar Research Establishment
(Ministry of Supply),
Malvern, Worcs. March 1.

- ¹ Machin, K. B., Ryle, M., and Vonberg, D. D., *Proc. Inst. Elec. Eng.*, 80, Pt. III, 127 (1953).
- ² Brown, R., Hanbury, Jennison, R. C., and Das Gupta, M. K., *Nature*, 170, 1061 (1952).
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- ⁴ Stanley, G. J., and Elee, D. B., *Aust. J. Sci. Res.*, A, 3, 234 (1950).
- ⁵ Ryle, M., Smith, F. G., and Mismore, B., *Mon. Not. Roy. Astro. Soc.*, 110, 508 (1950).
- ⁶ Brown, R., Hanbury, and Hazard, O., *Mon. Not. Roy. Astro. Soc.*, 112, 123 (1952).
- ⁷ Mills, B. Y., *Aust. J. Sci. Res.*, A, 5, 266 (1952).
- ⁸ Observatory, 73, 188 (1953).
- ⁹ Hubble, E., *Astrophys. J.*, 79, 8 (1954).
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- ¹³ Piddington, J. H., and Minnett, H. O., *Aust. J. Sci. Res.*, A, 5, 17 (1952).

Temperature Distribution in an Electrically Heated Filament

THE distribution of temperature in a filament electrically heated *in vacuo* has been studied by several previous authors. The differential equation defining the steady state is:

$$\frac{dT}{dx^2} + \frac{5}{2} a (T_m^4 - T^4) = 0, \quad (1)$$

in which T is the temperature at a distance x from one of the ends, T_m is the value to which the temperature T_l at the centre tends as the length $2l$ of the filament is increased indefinitely, keeping the heating current the same, and a is a constant determined by the cross-section of the filament, its thermal conductivity and the emissivity of its surface. Using the boundary conditions $T = \theta$ when $x = 0$, and $dT/dx = 0$ when $x = l$, one obtains¹

$$x = \int_0^T [\delta a T_m^4 (T_l - T) - a (T_l^4 - T^4)]^{-\frac{1}{2}} dT, \quad (2)$$

the value of T_l occurring in (1) being determined by the condition that, when the upper limit of the integral is made equal to T_l , x should become l .

In a recent paper² it was shown that though the integral cannot be evaluated directly, it can be expanded as a convergent power series. The filament can be divided for this purpose into two distinct regions, region A comprising a certain length near the middle, and region B outside it, the power series referred to being different in the two regions.

Now, denoting $T_m - T$ by Δ , it can be shown that:

$$\Delta \exp f(\Delta) = \exp \pm x\sqrt{A} \quad (3)$$

are solutions of (1), where

$$A = 10 a T_m^3 \quad (4)$$

and

$$f(\Delta) = \frac{1}{2} \frac{\Delta}{T_m} + \frac{1}{16} \frac{\Delta^2}{T_m^2} - \frac{1}{240} \frac{\Delta^3}{T_m^3} - \dots \quad (5)$$

The effect of the finite temperature coefficient of the thermal conductivity, and of the other constants, can also be taken into account by replacing the factors $\frac{1}{2}$, $\frac{1}{16}$, $-\frac{1}{240}$, ... by A_1 , A_2 , A_3 , ... which can be calculated. For a tungsten filament with $T_m = 2,400^\circ \text{K}$, $A_1 = 0.75$, and the other A 's are much smaller.

In the region where $\exp f(\Delta)$ is close to unity, a general solution for the finite filament can be obtained by suitably combining the two particular solutions given by (3). The corresponding two terms in the general solution are obviously such that one of them increases rapidly and the other decreases rapidly as we move away from the centre of the filament. If $T_m - T_l$ is sufficiently small, the latter term may become negligible in comparison with the former, while Δ still remains small enough to permit our combining the two particular solutions. When this has happened, the need to keep $\exp f(\Delta)$ close to unity disappears. We thus obtain a *practical* general solution that is applicable over the whole length of the filament, namely:

$$\begin{aligned} \Delta \exp f(\Delta) &= \Delta_0 \exp f(\Delta_0) [\exp -x\sqrt{A} + \exp \{- (2l-x)\sqrt{A}\}] \\ &= \Delta_0 \exp f(\Delta_0) \exp -l\sqrt{A} (\exp q\sqrt{A} + \exp -q\sqrt{A}), \end{aligned} \quad (6)$$

where $\Delta_0 = T_m - \theta$, and $q = l - x$ is the distance measured from the centre.

Now for a filament for which $T_m - T_l$ is small in comparison with T_m , which we shall refer to for convenience as a 'long' filament, the limit of the A -region is given by $\Delta_0 \sim 3(T_m - T_l)$. At this point it is found that the ratio of the second term inside the brackets in (6) to the first term has decreased to about $\exp(-3.6)$, that is, below 3 per cent. Taking for convenience this fraction, namely 0.03, as small in comparison with unity, we can readily investigate how small $T_m - T_l$ should be in comparison with T_m in order that (6) may hold over the whole length of the filament to at least this degree of accuracy.

It may appear at first sight that the criterion for our being able to combine the two particular solutions, namely, that $\exp f(\Delta)$ should be close to unity, will become increasingly difficult to satisfy as Δ increases. But actually, owing to the disparity in the magnitudes of the two terms to be combined, which increases rapidly as one moves away from the centre, the working criterion becomes $f(T_m - T_l) < 0.03$, or $(T_m - T_l) < 0.04 T_m$. When this is secured, (6) will fit with observation to a much closer accuracy than 3 per cent, the accuracy increasing rapidly as one moves away from the centre of the filament.

The results obtained earlier for such a filament, on the basis of the series-expansion of the integral—namely, the parabolic variation of temperature in the A -region, the closeness of the distribution outside the A -region to that of a similar infinitely long filament heated by the same current and the logarithmic distribution at the top of this range—all come out as special cases of (6).

By putting $x = l$ in (6), one obtains a useful relation for the temperature T_l at the centre of a long filament, as a function of its length, namely:

$$T_l = T_m - 2\Delta_0 \exp f(\Delta_0) \times \exp -l\sqrt{A}, \quad (7)$$

in view of which (6) may also be written in the convenient form,

$$\Delta \exp f(\Delta) = \frac{1}{2} (T_m - T_l) (\exp q\sqrt{A} + \exp -q\sqrt{A}), \quad (8)$$

which is applicable over the whole length of a long filament.

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Feb. 12.

¹ See Carslaw, H. S., and Jaeger, J. O., "Conduction of Heat in Solids", 185 (Oxford: Clarendon Press, 1947).

² Krishnan, K. S., and Jain, S. C., *Nature*, 173, 166 (1954); *Proc. Roy. Soc., A* (in course of publication).

A New Technique for Investigating Surface Flow in Metal-working Processes

DURING the plastic deformation of metals in shaping processes, there is relative movement between the flowing metal and the tools. An attempt was made by Siebel and Osenberg¹ to deduce this relative movement by noting the distortion of a grid scribed

to the first, and a curved scratch is produced. The final shape is like that of a fish-hook. Fig. 1 shows stages in the development of scratches through the arc of contact. The specimen was prepared by interrupting the rolling process and removing the strip for examination.

A preliminary investigation based on the measurement of surface scratches has led to several conclusions regarding the rolling process.

(1) The projected length of scratch in the rolling direction is close to the length predicted by a simple theory based on the assumption that the deformation is homogeneous.

(2) The neutral position, which is related to the frictional conditions in rolling, can be directly observed.

(3) The spread of elements in the surface can be measured by observation of the length of the scratch projected in the lateral direction.

(4) Since the direction of the growing end of a scratch within the region of contact coincides with the direction of the frictional force at that point, maps of frictional force direction in the region of contact may be constructed. In theories of rolling it has always been assumed that the frictional forces are parallel to the rolling direction. Observations have shown that even with small lateral spread (less than 1 per cent) this is far from being the case.

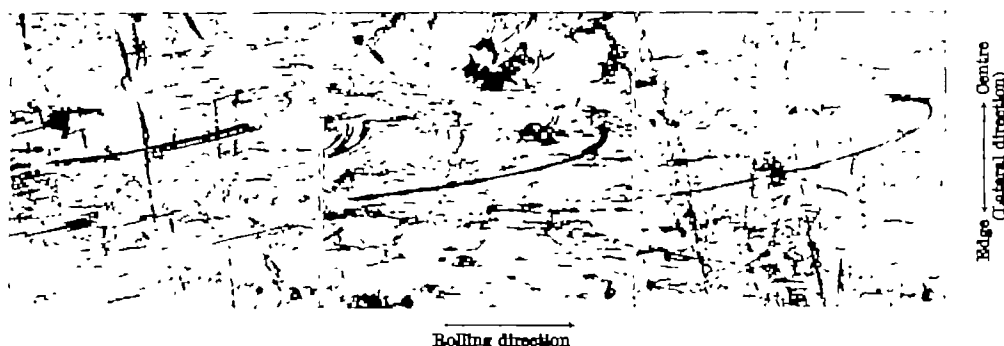


Fig. 1. Surface scratches on partly rolled copper strip (3 in. wide $\times$ 0.2 in. thick: reduction, 15 per cent)
(a) Between entry and neutral position; (b) near neutral position; (c) at exit. $\times$ 150

on the surface of strip before further rolling. The accuracy was not high, however, and the method yielded little information on surface flow.

It occurred to us that small projections on the surface of the rolls or tool faces might give rise to ploughed tracks on the surface of the metal undergoing deformation, and that such markings might provide illuminating evidence regarding the relative movement. We have observed that tracks or surface scratches are, in fact, produced by the adventitious minute projections normally present on rolls and platens. These surface scratches provide a valuable means of investigating the topography of surface flow during deformation.

When a metal strip is reduced in thickness by passing it between cylindrical rolls, its speed, on entering the zone of deformation, is less than that of the roll periphery. The strip is accelerated until, at some 'neutral position' within the region of contact, roll and strip surfaces are moving with the same velocity, and the strip finally emerges moving more rapidly than the rolls. The relative movement which takes place generates the surface scratches mentioned above. Spreading in the lateral direction adds a second component of relative velocity at right angles

Further work using the technique described here is in progress.

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Feb. 3.

¹ Siebel, H., and Osenberg, H., *Mitt. K.-W.-Inst. f. Eisenforschung*, 10, 23 (1934).

Refractive Index of Concentrated Protein Solutions

AN accurate knowledge of the specific refraction increment α , or dn/dc , of proteins is important in measurements which involve the use of the ultracentrifuge, electrophoresis and light-scattering. Recently, it has become important in connexion with cytological methods of refractometry¹ and mass determination² of living cells. The refraction increment has hitherto usually been measured only at rather low concentrations. The highest concentration reported seems to be by Howard³ in 1920, who found that the variation of refractive index with concentration of haemoglobin was linear up to about 17 per

cent. Armstrong *et al.*⁴ found that α for crystalline serum albumin was constant up to a concentration of 14.6 per cent. Since in cytology considerably higher concentrations may be encountered, and it is well known that the refractive indices of some substances, for example sugars, do not vary quite linearly with concentration, we have measured the refractive indices of bovine serum albumin solutions up to concentrations exceeding 50 per cent. In order to avoid the difficulties associated with the measurement of protein concentrations by dry-weight or nitrogen determinations, we have obtained a factor proportional to the concentration by measuring the optical density at 278 m μ , using a Hilger 'Uvispek' ultra-violet spectrophotometer. Deviations from the Beer-Lambert law were avoided by diluting all samples accurately by different amounts to give approximately the same final optical density. The final concentration was about 0.2 per cent in each case, giving optical densities between 1.0 and 1.3 for a 1-cm. path-length.

Fig. 1 shows the results obtained with non-crystalline bovine serum albumin fraction V (Armour) dissolved in distilled water. Refractive indices were measured at 20° C. in an Abbe type refractometer at λ 5780 Å. Optical density values were converted to protein concentration by using the published figure⁵ of 6.6 for $E(1\%, 1 \text{ cm.})$. The probable errors increase with concentration because of the difficulty in manipulating and measuring very viscous solutions. Nevertheless, the refractive index increases linearly with concentration up to at least 45 per cent. The value of α obtained was 0.00182. This is in reasonably good agreement with values found by others^{4,6}; but in view of possible uncertainties in the extinction coefficient and hence in the protein concentrations, no claims for high accuracy are made. The main purpose of this investigation was to determine whether α remained constant with increasing concentration.

Excellent linearity has also been obtained in the case of peptone (Evans bacteriological) up to 50 per cent concentration. The value for α in this case was

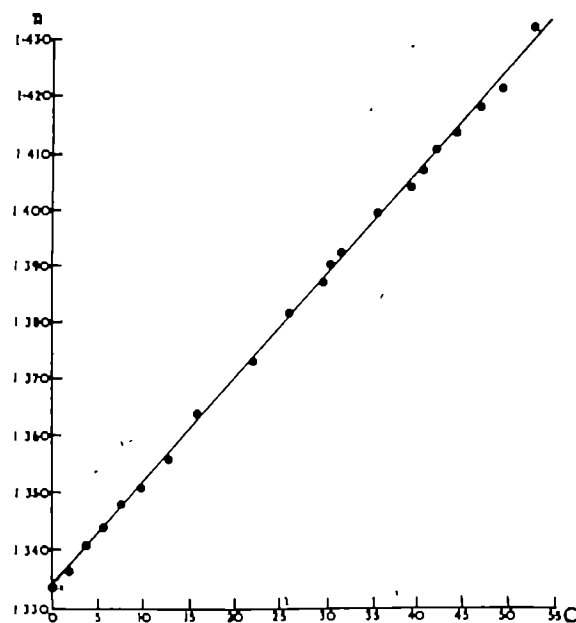


Fig. 1. Variation of refractive index (n) of bovine serum albumin solution with concentration (C)

0.00174, but this was based on the weight of peptone as supplied. Since the moisture content of this product is approximately 5 per cent, the corrected value for α would be 0.00183, again in good agreement with values obtained for proteins.

These results suggest that: (1) unlike the sugars, at least some proteins and protein derivatives have constant values for α over a wide range of concentrations; (2) the breakdown of proteins into components of lower molecular weight has very little effect on α . This confirms the observation of Robertson⁷ that complete digestion of sodium caseinate by trypsin had no detectable effect on the refractive index. We have also been unable to detect any change in refractive index during the digestion of bovine serum albumin by pepsin.

We wish to thank Dr. P. W. Kent for the loan of the refractometer. This work was assisted by a grant from the Medical Research Council to one of us (S. T.) and by grants from the Royal Society and the Rockefeller Foundation.

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Cobalt as a Carcinogen

The effects of various metals on living cells in tissue culture are being investigated in this Laboratory, and a non-lethal disturbance of normal mitosis produced in chick fibroblasts by cobalt (as chloride) has already been reported¹. This effect, which is characterized by the persistence of the nucleoli in mitotic cells throughout prophase into meta-, ana- and telo-phase, appears to be specific for cobalt, inasmuch as no comparable effect is produced by nickel, iron, zinc, chromium, manganese or beryllium in sublethal concentrations.

The cobalt is added to give a concentration of approximately 10×10^{-6} gm./ml. cobalt, to ordinary hanging-drop cultures after 24-hr. growth, when mitosis is approaching its peak; under these conditions, the effect reaches a maximum some 10-14 hr. later, when almost all dividing cells display persistent nucleoli. This type of culture begins to deteriorate after about 48 hr. unless the tissue is transplanted, and hence the prolonged action of cobalt on the cells cannot be studied. With the Maximow technique (double-cover slip method), in which the tissue can be washed and replenished with fresh medium without disturbing the cells, it is possible to prolong the life of the culture so that by adding the cobalt at some convenient point in the procedure, the effect can be observed over a longer period.

Some preliminary experiments on these lines produced at 72 hr. many giant cells in metaphase, each carrying one or more large cytoplasmic nucleoli.

Observation of such living cells in the warm chamber by phase-contrast illumination showed that they became reconstructed into mononucleate cells without any division taking place; the cell retains one or more large cytoplasmic nucleoli. These persistent cytoplasmic nucleoli are clearly demonstrated when the cultures are fixed in methyl alcohol or acetic-alcohol and stained with methyl green-pyronin. Stained by this method, the giant metaphase cells also show many pyronin-staining granules in the cytoplasm, which would appear to indicate an accumulation of ribonucleic acid.

These cellular changes produced *in vitro* were not lethal, and it seemed interesting to see what would happen if cobalt was allowed to act locally on an animal tissue *in vivo*. Accordingly, some pure 400-mesh cobalt powder was mixed with fowl serum, and a quantity of 0.028 gm. cobalt in 0.4 ml. serum was injected into the thigh muscles of rats 2-3 months old of the hooded strain. Ten male and ten female rats were so treated and a further ten male and ten female animals of the same strain and age were similarly injected with fowl serum only. There was little or no reaction immediately after the injection, and nothing was observed for some five months, when two male rats began to develop tumours at the site of injection. One month later, these tumours measured approximately 3 cm. $\times$ 3 cm. and at autopsy were found to be malignant neoplasms. I am indebted to Dr. A. Glücksmann of this Laboratory for the following report on the histological characteristics. One tumour was a highly cellular and fairly undifferentiated rhabdo-myo-fibrosarcoma and the other a cellular rhabdo-myo-fibrosarcoma with slightly better differentiation. The first one produced a definite lymph node metastasis. Sections of these tumours stained with methyl green-pyronin showed persistent nucleoli in a few of the mitotic cells. In addition to these two tumours in males, at six months one female began to show a tumour at the site of injection; this is still growing and is now approximately 3 cm. in diameter. At the present time—seven months from injection of the cobalt—two more females have tiny nodules at the site of injection.

Further experiments are in progress to repeat these observations and also to extend the work to other metals. The neoplastic process evoked may not be related in any way to the cytological effects observed *in vitro*. The fact that nickel can produce rat tumours¹ and yet does not cause the persistent nucleolar effect *in vitro* would seem to argue against any such relationship.

This work is being done with the support of the British Empire Cancer Campaign.

Note added in proof. The tumour in the female rat reached a size of approximately 4 cm. $\times$ 3 cm. at 7½ months, and histological examination by Dr. A. Glücksmann showed it to be a moderately differentiated fibrosarcoma with giant cell formation. This tumour was transplanted into other rats of the same strain, and so far 5 'takes' out of 20 have occurred. One of the nodules mentioned in a female rat developed into a cellular fibrosarcoma, and a further large tumour is growing in another male rat.

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Soluble Feather Keratin

The stability of feather keratin in the solid state is due to cross-linking of the polypeptide chains by hydrogen bonds, disulphide linkages and electrostatic forces, and under conditions where these bonds are broken solutions of the protein are obtained. The molecular characteristics of the particles in solution are of interest because of their relevance to the interpretation of the data obtained by the diffraction and scatter of X-rays by solid keratin, and the interaction of the particles in solution is relevant to the problem of the manufacture of fibres from the regenerated keratin. I wish to present here data of this sort for soluble feather keratin and in particular to identify the keratin monomer, which it was considered would be a particle in which bonding between the polypeptide chains due to hydrogen bonds, disulphide linkages and electrostatic attraction was absent.

80-85 per cent of chicken feather keratin dissolves in 10 M urea, 0.1 M bisulphite, 0.05 M phosphate (pH 8.5) after 18 hr. extraction at 40° C. The soluble protein, SH-keratin, remains in solution when the urea concentration is reduced to 5 M, and in this solution the cysteine-cystine ratio of the keratin is a function of the pH (Table 1).

When these solutions of SH-keratin are dialysed against water, a solution, or, when the protein concentration is greater than about 3 per cent, a gel, is produced. The solution or gel can be dried by sublimation to give a solid which contains no cysteine and 90 per cent of the cystine in the original feather; this is taken as evidence that few thio-ether or other stable cross-linkages are formed from the cystine and bisulphite. Treatment of this solid with performic acid gives a solution from which a protein (cysteic acid-keratin) can be recovered that contains neither cystine nor cysteine. In 0.05 M sodium carbonate, cysteic acid-keratin migrates with a single boundary on electrophoresis.

The graphs relating the osmotic pressure-concentration ratio to the concentration of SH-keratin in 5 M urea, 0.1 M bisulphite, 0.05 M phosphate, at pH 8 and at pH 8.5, and of cysteic acid-keratin in this solvent at pH 8.5, extrapolate with different slopes to the same value at zero concentration corresponding to a molecular weight of 10,000. Cysteic acid-keratin exhibits ideal behaviour in the concentration range 0.1 per cent, but SH-keratin deviates from ideal behaviour, indicating that association occurs with increasing concentration. In Table 1 the extent of the association is given as the ratio of the values of the osmotic pressure-concentration ratio at zero and 1 per cent concentration.

Measurements of light-scattering give confirmation of the association of SH-keratin at pH 8.5 and give a value of the weight average molecular weight of 11,000 in infinitely dilute solution.

From the intrinsic viscosity the axial ratio of SH-keratin in 5 M urea, 0.1 M bisulphite, 0.05 M phosphate (pH 8.5) and of cysteic acid-keratin in 5 M urea, 0.1 M sodium chloride, 0.05 M phosphate (pH 8) is 13 (calculated from Simha's equation², assuming that the proteins are unsolvated and are prolate ellipsoids). The specific viscosity of cysteic acid-keratin is independent of concentration in the range 0.1 per cent, but that of SH-keratin increases with increasing concentration; this is taken as evidence for the formation of increasingly asymmetrical particles by association.

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Table 1. OSMOTIC PRESSURE AND CYSTEINE-CYSTEINE CONTENT OF KERATIN IN UREA SOLUTION

The numbers of —SH and —S—S— groups are calculated on the basis of each monomer having a molecular weight of 10,000 and six potential SH groups. The molecular weight is obtained from the value of P/C at zero concentration

Solute	Solvent	pH	Mol. wt.	$\frac{*P/C: C=0}{P/C: C=1}$	No. of —SH groups in monomer	No. of S—S groups in monomer
SH-Keratin	5 M urea	8	10,200	1.08	5.2	0.4
SH-Keratin	0.1 M bisulphite	8.5	9,500	1.45	2.2	1.9
	0.05 M phosphate					
	5 M urea					
SH-Keratin	0.1 M bisulphite	8.5	9,500	1.58	2.4	1.8
	0.05 M phosphate					
	0.2 M ethanol					
SH-Keratin	5 M urea	8.5	9,700	1.00	—	—
	0.1 M bisulphite					
	0.05 M phosphate					
Cysteic acid-keratin	0.2 M mercapto-ethanol	8.5	10,200	1	0	0
	5 M urea					
	0.1 M bisulphite					

* P, osmotic pressure; C, concentration

SH-keratin in urea, bisulphite, phosphate (pH 8.5), and cysteic acid-keratin in urea, sodium chloride, phosphate (pH 6) each sediment with a single symmetrical boundary on ultracentrifugation in the synthetic boundary cell of Pickels, Harrington and Schachman². Corrected for water at 20° as solvent, the sedimentation constant of each in infinitely dilute solution is 1.05 Svedberg units. This value, with the frictional ratio obtained from the viscosity data, gives the molecular weight as 10,100.

If the cysteine residues are equally distributed among the polypeptide chains of SH-keratin, then each particle of molecular weight 10,000 has potentially six SH groups. In Table 1 are given the number of —SH and —S—S— groups in each particle of keratin. Consideration of these results, together with the degrees of association that the osmotic pressure and light-scattering measurements reveal, suggests that the association only occurs when there are present both —SH and —S—S— groups. The addition of *B*-mercaptoethanol to a solution of SH-keratin in urea, bisulphite, phosphate at pH 8.5 decreases the degree of the association, whereas the addition of ethanol does not (Table 1). It is therefore possible that, with increasing concentration of SH-keratin, intermolecular —S—S— bonds form at the expense of intramolecular bonds through the intermediary action of the —SH groups³. The —S—S— bonds in SH-keratin in infinitely dilute solution are intramolecular, since the protein under these conditions has the same molecular weight as cysteic acid-keratin, which contains no cystine.

Further osmotic pressure measurements have shown that the molecular weight of keratin in infinitely dilute solution is constant in the range of urea concentration 10–5 M, of ionic strength 0.17–0.64, and for preparations which contain 0.2–9 gm. mol. cystine per 10,000 gm. keratin. It is therefore probable that under these conditions cross-linking of the polypeptide chains is absent and that we are indeed measuring the molecular size of the monomer.

I wish to thank Prof. K. J. Mysels for his advice during this work, which was done during the tenure of the Rubberst Fellowship of the University of Southern California and a Fulbright travel grant. The ultracentrifugation was done at the Sloan-Kettering Institute for Cancer Research, New York, and I am indebted to Dr. Mary L. Petermann for her hospitality and instruction. Full details of these

experiments will be published in the *Biochemical Journal*.

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Physical State of Deoxyribonucleic Acid in Rat Thymus Homogenates

In a recent communication, Anderson¹ has shown that when the thymus of the freshly killed rat is homogenized and then dissolved in *M* sodium chloride, extremely viscous solutions are obtained. It is clear that the high viscosity is primarily due to the deoxyribonucleic acid present, but it is much greater than that of solutions containing the same amount of deoxyribonucleic acid isolated by the usual technique. To explain this discrepancy, Anderson suggested that in freshly prepared tissue homogenates deoxyribonucleic acid has a much higher molecular weight than the chemically isolated substance. This explanation is valid only if the deoxyribonucleic acid is molecularly dispersed in the tissue homogenates and does not interact with any other compound present. Using rat thymus homogenized in 0.14 M sodium chloride, filtered through nylon cloth and then diluted with an equal volume of 2 M sodium chloride, evidence has been obtained which suggests that the deoxyribonucleic acid is probably present in the form of aggregates in which nucleic acid molecules are cross-linked by protein bridges.

The homogenates, containing 0.020–0.003 per cent of deoxyribonucleic acid, were centrifuged at 80,000 *g* for five minutes. In all cases a clear non-viscous supernatant was obtained which could easily be poured off from the small gel-like pellet of sediment. Tests using the Dische diphenylamine reaction² showed that no deoxyribose was left in the supernatants. This high rate of sedimentation means that either aggregates are present or that the molecular weight of the deoxyribonucleic acid is far greater even than that suggested by Anderson.

The original homogenate in 0.14 *M* sodium chloride was centrifuged at low speed to remove debris and the insoluble deoxyribonucleoprotein, and the concentration of protein left in the supernatant was determined using the Mehl biuret method³. This was then compared with the concentration of protein in the supernatants obtained by centrifuging the *M* sodium chloride solutions at high speed as described above. It was found that the amounts of protein were the same to within 2 per cent. Since complete dissociation of the deoxyribonucleoprotein would have increased the protein concentration by 20 per cent, it can be concluded that either most of the histone has sedimented along with the deoxyribonucleic acid and therefore that in *M* sodium chloride dissociation is far from complete, or that any histone liberated by dissociation of the nucleoprotein has been replaced by other proteins.

Further evidence that the protein associated with the nucleic acid contributes to the viscosity has been obtained by hydrolysing it with chymotrypsin. Three solutions of the homogenate in *M* sodium chloride, one containing chymotrypsin and one deoxyribonuclease, were incubated at 25° C. for 16 hr. The presence of deoxyribonuclease reduced the viscosity to one-quarter of that of the solution containing no added enzyme, while the presence of chymotrypsin reduced the viscosity to one-half.

Viscosity measurements with the *M* sodium chloride solutions are unsatisfactory, first because of their inhomogeneity and secondly because they exhibit thixotropy. Chymotrypsin and deoxyribonuclease greatly reduce the thixotropic nature of the solutions. The viscosities of the solutions treated with enzymes have been compared with the viscosity of the untreated solution after this has been run through the viscometer a sufficient number of times for the rate of flow to become reasonably constant. When compared with the viscosity of an untreated solution which has been run several times through the viscometer, the effect of X-ray irradiation roughly parallels the effect on solutions of isolated nucleic acid⁴. 80 r. produces a barely significant fall in viscosity, 800 r. an appreciable decrease, and 8,000 r. a marked decrease.

Since deoxyribonucleic acid is still associated with protein and the protein contributes to the viscosity of this system, the viscosities cannot be used directly for determining the molecular weight of the nucleic acid.

I thank Prof. J. A. V. Butler for his interest and advice during the course of this work. This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

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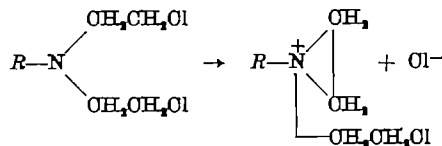
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Mutagenic Activity of Ethylenimine Picrate

RESEARCHES carried out during the past few years to investigate the precise mechanism of action of nitrogen mustards and related compounds suggest the

primary importance of the $\begin{array}{c} \text{CH}_3 \\ | \\ \text{—N—} \\ | \\ \text{CH}_3 \end{array}$ group, which

appears in the molecule of nitrogen mustard, when in aqueous solution, through an intramolecular cyclization process:



Nitrogen mustard-like actions have been demonstrated in monofunctional compounds containing either a preformed ethylenimic ring or capable of forming it, and in ethylenimine itself¹⁻⁴.

On the other hand, Goldacre, Loveless and Ross⁵ suggest that the presence of at least two functional groups in the molecule of mustard and related compounds is required to permit the molecule to react at two distinct points situated either on a single one or on two contiguous protein chains. There was therefore the possibility that cross-linkage could play a primary part in the mechanism of action of nitrogen mustards and related compounds.

In order to evaluate the importance of a single ethylenimic group for the inhibition of aerobic glycolysis in neoplastic tissues, I began studying the action of ethylenimine picrate (kindly prepared by Simes Research Dept., Milan) during 1951. This substance was chosen from among several possible monoethylenimic compounds because of its relatively higher stability.

Tests carried out, according to the Warburg technique, demonstrated that the inhibition-rates of Rous sarcoma and benzopyrene sarcoma glycolysis obtained by ethylenimine picrate were comparable to those obtained by methyl-bis(2-chloroethyl) amine, while inhibition obtained by picric acid is small⁶.

It therefore became clear that the presence of a single ethylenimic group was sufficient to permit an inhibition-rate of aerobic glycolysis in tumour cells comparable to that produced by bifunctional nitrogen mustards.

Consequently, it appears that, contrary to the hypothesis of cross-linkage, the presence of two or more functional groups is not required for a strong inhibition of neoplastic cell glycolysis.

Extending our researches on the mustard-like properties of ethylenimine picrate, we carried out investigations in *Drosophila melanogaster* in order to determine whether that substance has mutagenic activity.

The rate of mutation was estimated by the incidence of sex-linked lethals detected by the *ClB* test. The substance was mixed with the food of the larvae in a concentration of 1×10^{-4} . The emerging ♂♂ were treated again by spraying the substance in a concentration of 1×10^{-3} for 8–10 min. and then mated to fresh ♀♀ virgin *ClB*.

The results obtained (see accompanying table) indicate that, at the concentration employed, ethyl-

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Compound	No. of chromosomes tested	No. Lethals	%
Ethylennimine picrate	526	10	1.9
Picric acid	520	1	0.18
Controls	511	0	0

ethimine picrate increases the sex-linked lethal mutation-rate quite significantly, while picric acid does not. Dubious, probably negative, data were obtained also by Auerbach and Robson⁹ employing picric acid.

The demonstration of the mutagenic activity of ethylennimine picrate, together with the demonstration of its inhibitory action on aerobic glycolysis in neoplastic tissues, confirms the importance of the ethylennimine ring in the mechanism of action of nitrogen mustards and ethylennimine compounds, and affords additional evidence in favour of the assumption that the biological activity of mustards and ethylennimine compounds is not essentially due to the cross-linkage mechanism.

Thanks are due to Prof. G. Montalenti for his many helpful suggestions, and to Profs. R. Dohrn and G. Montalenti for their kind hospitality.

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Denitrification of Nitrite by a Species of *Achromobacter*

THE effect of oxygen on the process of denitrification continues to be a subject of research, and it may, therefore, be of interest to record some observations made in the University of Melbourne with a species of *Achromobacter*. The organism, which was isolated from soil, reduced nitrite but not nitrate to nitrogen gas.

The organisms were harvested, after incubation for 48 hr. at 25° C., from the surface of a medium which contained: 'Difco' peptone, 10 gm.; 'Difco' yeast extract, 5 gm.; sodium chloride, 5 gm.; agar, 20 gm.; tap water, 1 litre; sodium nitrite (when supplied), 2 gm. The pH of this medium was between 6.8 and 7.2. Anaerobic incubation was carried out under nitrogen or hydrogen in anaerobic jars.

After harvesting, the cells were washed twice and suspended in M/15 phosphate buffer, pH 8. Borate buffer was not used because the nitrite reduction-rate was lower, although it was found that the oxygen absorption on sodium lactate remained unchanged. Cell suspensions obtained in different conditions were adjusted to the same turbidity for comparison of activity. The activity of cell suspensions was expressed as the rate of reduction of sodium nitrite in p.p.m./hr.

Table 1

Conditions of growth	Rate of reduction of sodium nitrite
Aerobic with sodium nitrite	180 p.p.m./hr.
Aerobic, no sodium nitrite	180 "
Anaerobic (hydrogen), with sodium nitrite	1,080 "
Anaerobic (hydrogen), no sodium nitrite	600 "
Anaerobic (nitrogen), with sodium nitrite	1,140 "
Anaerobic (nitrogen), no sodium nitrite	840 "

These rates were determined by following the disappearance of nitrite from the suspensions with sodium lactate, in excess, as the substrate. Suspensions were placed in a constant-temperature bath at 25° C. and were rendered anaerobic by the passage of a stream of nitrogen gas. Nitrite was estimated colorimetrically by the sulphanilic acid- α -naphthylamine method. Nitrite was added to give an initial concentration of about 200 p.p.m., and this initial concentration was estimated.

Table 1 shows the effect of the presence and absence of oxygen on cultures growing with and without nitrite.

These results indicated that the absence of oxygen was a more important factor than the presence of nitrite in the production of highly active cells. Under anaerobic conditions, growth was very slight; but highly active cells could be produced in good yields if a period of anaerobic growth followed an initial aerobic growth. Anaerobic incubation of washed suspensions of cells grown aerobically did not result in increased activity.

A pronounced reduction of 'nitritase' activity was found in media rendered deficient in iron, and the addition of 0.5 p.p.m. of iron, supplied as ferrous sulphate, resulted in cells of normal activity. Owing to the use of solid media, the iron requirement is not accurately known.

Spectroscopic examination of cell suspensions of widely different 'nitritase' activity did not show any relation between the intensity of cytochrome bands and the degree of activity.

The rate of reduction of nitrite did not differ when the reaction was carried out under hydrogen and nitrogen. It therefore did not appear likely that hydrogenase was involved.

Some inhibitor studies were made both with whole cells and with cell-free extracts which were prepared by shaking heavy suspensions with Ballotini beads. The cell debris was removed by centrifugation. The results given in Table 2 are regarded as an initial

Table 2

Inhibitor	Concentration	Preparation	Inhibition
Potassium cyanide	M/10,000	whole cells	73
Potassium cyanide	M/1,000	whole cells	100
Potassium cyanide	M/1,000	extract	85
Hydroxylamine	M/500	whole cells	50
Hydroxylamine	M/500	extract	90-100
Sodium azide	M/500	whole cells (18 hr. exposed)	40
Sodium azide	M/200	extract	73
8-Hydroxyquinoline	M/1,000	whole cells	inhibited and partly reversed by light
Carbon monoxide	qualitative	whole cells	inhibited
Hydrogen sulphide	qualitative	whole cells	inhibited
Copper sulphate	M/1,000	whole cells	99
Silver nitrate	M/1,000	whole cells	96
Phenylmercuric acetate	M/2,500	whole cells	84
Phenylmercuric acetate	M/5,000	extract	80-100
m-Amino p-hydroxy-phenylarsenoxide	M/500	whole cells	93
m-Amino p-hydroxy-phenylarsenoxide	M/1,000	extract	85

survey only. The inhibiting compounds have not been tested over a range of concentrations. Differences have been found in the behaviour of whole cells and extracts. Evidence was also found that the pH optimum of cell extracts was nearer pH 7 than 8. It should be noted that azide interferes with the colorimetric estimation of nitrite in such a way as to give lower than actual inhibition figures. To avoid this difficulty, the percentage inhibition for azide with a cell extract was derived from the measurement of nitrogen production manometrically. The results quoted are the percentage inhibition of the rate of nitrite reduction.

Inhibition by the last two compounds was relieved by the addition of thioglycolic acid. Tryparamide did not inhibit. It is possible that a part of the enzyme system involves an active sulphhydryl group which is produced under anaerobic conditions. This may not be specifically related to the 'nitritase' system, since an increased activity followed anaerobic growth in the absence of nitrite.

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Effect of DDT on the Metabolism of Khapli Wheat Seedlings

JOHNSON¹ reported that DDT (dichlorodiphenyl-trichloroethane) affected the metabolism of Khapli wheat so that the seedling leaves became susceptible to a race of *Puccinia graminis* var. *tritici* to which they are normally resistant. The response to DDT was highly specific, as only one other of the resistant wheats tested (Arnautka) showed any indication of susceptibility consequent on spraying.

To determine the specific nature of the response of Khapli wheat leaves to DDT, alcoholic extracts were obtained from DDT-treated and non-treated leaves, 2, 6, 9 and 14 days after treatment. The extracts were concentrated *in vacuo* and, after a short period of storage in toluene, they were chromatographed using *n*-butanol-formic acid-water mixture as used by Wiggins and Howarth². A visual comparison of the spots on the chromatograph revealed a marked change, as a consequence of the leaf being sprayed with DDT solution, in the con-

centration of amino-acids present in sufficient quantity to be detected by 0.1 per cent ninhydrin. Whenever an amino-acid is present in both the extract from the control and the treated leaves, it is present in greater amount in the latter.

Preliminary results with the chromatography of the simple sugars present in the alcoholic extracts reveal that they also are present in greater quantities in the DDT-treated leaves than in the non-treated leaves.

This study is part of an attempt to determine the nature of rust resistance. Evidently the DDT alters the metabolism in such a way that free amino-acids and simple sugars accumulate in the leaf. The effect may be due to an inhibition of synthesis of proteins and carbohydrates. However, the dry weight of the treated seedling leaf increases more rapidly than does that of the non-treated leaf (see Fig. 1). This would suggest that certain substances that normally are transported during the ontogeny of the leaf are not translocated from the treated seedling leaf. In any event, the observations recorded here prove that DDT extensively alters the metabolism of the Khapli wheat seedling. Further study should reveal which, if any, of these alterations are responsible for the increase in susceptibility of the seedling.

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² Wiggins, I. F., and Howarth, W. J., *Nature*, **170**, 279 (1952).

Development of the Syncytial Endosperm of *Cocos nucifera*

DUTT¹ has recently summarized her investigations on nuclear behaviour in the developing endosperm of *Cocos nucifera*. Several of her observations are at variance with statements we have previously made^{2,3} and with some of our more recent findings⁴. Since these divergent opinions arise in part from a difference in terminology and in part from misinterpretations of the anatomical structure of the coconut, we wish to present several points to clarify this matter.

Following fertilization, the embryo sac of *Cocos* enlarges rapidly and becomes filled with a clear watery fluid (milk) in which large amoeboid nuclei and fine cytoplasmic particles are suspended. This milk will be referred to as the 'liquid syncytium'. Dutt has not been able to detect free nuclei in this liquid syncytium in the early stages of its development; but they may be easily demonstrated by centrifuging the milk and examining the sediment. Since they are widely dispersed in the liquid they might easily be overlooked in unconcentrated milk. After fertilization, and until the fruit reaches an overall length of approximately 150 mm., an examination of the sac cavity reveals that its boundary is composed of a closely packed layer of isodiametric cells which represents the specialized wall of the inner integument. According to Quisumbing and Julian⁵, the nucellus is digested prior to fertilization, and therefore this specialized cell layer probably represents an integumentary tapetum or endothelium. The endothelium is in direct contact with the milk and there is no cellular endosperm present at this stage. We have previously referred to this layer as

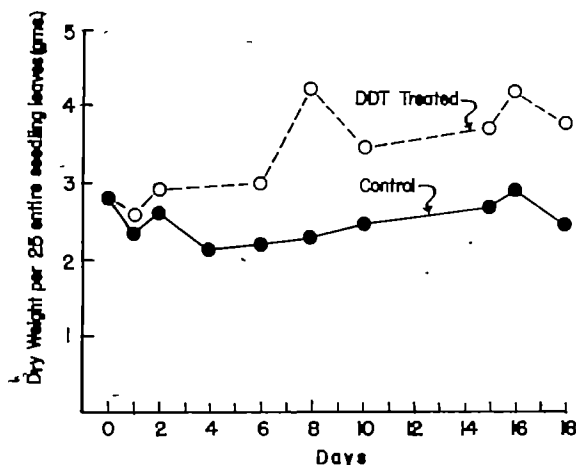


Fig. 1. The effect of DDT, during ontogeny, on the dry weight of the seedling leaf of Khapli wheat

the nucellus under the mistaken impression that this tissue was persistent. As the fruit reaches an overall length of approximately 100 mm. a number of large spherical cells suddenly appear suspended in the liquid syncytium. These cells, which may range from 50 to 300 μ in diameter, show varying numbers of nuclei (1-40). Our observations indicate that these cells, or endosperm vesicles, are formed in the liquid syncytium by the coalescence of cytoplasmic particles around nuclei or groups of nuclei which are floating free in the milk. Dutt has not mentioned these endosperm vesicles.

At a later stage when the fruit is approximately 150 mm. in length these endosperm vesicles and the free nuclei of the liquid syncytium commence to settle out of the milk and attach themselves to the surface of the endothelium. This deposition of vesicles and free nuclei commences at the lower end of the embryo sac cavity and progresses upward around the walls of the sac, thus forming a gelatinous syncytium in which the nuclei are very closely packed. This gelatinous mass of nuclei and cytoplasm soon becomes cellular, forming the meristem which develops the solid endosperm or familiar coconut meat. Dutt states that this meristem develops first at the micropylar end of the sac cavity and creeps progressively over the face of the endocarp, finally covering the entire wall of the cavity. She is apparently under the impression that the micropyle is located at the lower end of the cavity. Actually, however, since the ovule of *Cocos* is anatropous the micropyle lies directly below the hilum or soft eye at the stem end of the nut. As would be expected, the embryo is seated directly below the micropyle. Therefore, the stylar end of the fruit is oriented downwards as the fruit hangs on the palm, and the endosperm meristem is initiated at the antipodal end of the sac. Also, as pointed out above, this meristem forms on the endothelial surface and not on the endocarp, which is separated from the cavity by two thick integuments.

There is also some divergence between our observations⁸ and those of Dutt on the mode of nuclear division in the ripening embryo sac, since we have never been able to detect any mitotic divisions in the free nuclei of the milk, in the endosperm vesicles or in the younger stages of the gelatinous syncytium. In Dutt's opinion, mitosis occurs during all these stages, and she figures a nucleus in mitosis in a drop of milk. Since she claims not to have found any free nuclei in the milk "until a little of the endosperm, if only the barest film, has begun to form", it is probable that the nuclei she pictures were torn from the meristematic endosperm during the opening of the nut. We have frequently noted at this stage that large plates of meristematic cells will detach themselves from the endothelial walls, break up and float free in the milk if the nut is shaken. In the young cellular meristem at this stage mitoses are frequent. On the other hand, in the stages prior to formation of the meristem, we find that constricted or fragmenting nuclei are very abundant in both milk and endosperm vesicles. We have, however, found no evidence of spindle formation in connexion with these constricting nuclei, which leads us to believe that amitosis rather than mitotic division is characteristic of the syncytial stages. In addition, there are always numerous pycnotic nuclei here, which is suggestive of amitosis. While it is possible that the amitotic figures observed actually represent stages of nuclear fusion, this does not seem likely since the

greatest frequency of amitotic figures in the liquid syncytium is encountered at the same stage in development when the maximum number of nuclei appear there.

On all other features of the development of the fertilized embryo sac Dutt's observations and ours are in agreement.

This investigation has been aided by a grant from the American Cancer Society upon recommendation of the Committee on Growth, National Research Council.

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Control of Mitotic Activity

THE mechanically active phase of nuclear reproduction is closely associated with the appearance of polymerized deoxyribonucleic acid (DNA) on the chromosomes. Furthermore, it has been shown that cells containing little or no DNA do not divide¹ and that continued synthesis of this form of nucleic acid is essential for further nuclear reproduction². The actual synthesis of DNA appears to take place during interphase^{3,4}, although it is not yet fully established whether it is produced directly from the store of ribose nucleic acid (RNA) or from other sources. But whatever the processes involved, any modification leading to the disappearance or reduction of deoxyribonucleic acid from the cell will act as a mechanism whereby nuclear division may be regulated.

Such a mechanism appears to operate in the embryo sacs of *Vicia faba*, *V. sativa* and *Lens esculenta*, which I have been studying in relation to fertilization and embryo development. The differentiated egg and central fusion nuclei, which are not required to divide until the time of fusion with the male gametic nuclei, contain little or no DNA. With these nuclei, Feulgen gives a completely negative reaction while the methyl green-pyronin technique indicates the presence of ribonucleic acid only.

In the mature pollen grains, on the other hand, the generative nucleus is Feulgen-positive while the vegetative nucleus gives a negative reaction. This is similar to the observations of Painter⁵, Koller⁶ and Le Cour⁷ on the pollen grains of *Tradescantia*. Thus, during the process of differentiation the vegetative nucleus, which does not undergo further division, loses the ability to synthesize DNA. Support for this concept is provided by the case of *Sorghum*⁸, where the presence of supernumerary heterochromatic chromosomes, with a different DNA cycle, brings about the continued division of the vegetative nucleus, resulting in what has been called an 'encapsulated tumour'.

Thus, in contrast to the absence of DNA from the mature egg, central fusion and pollen tube nuclei which do not divide further, we have the generative

nucleus, which contains DNA, invariably dividing to produce two male gametic nuclei, both of which also contain DNA. Here it is interesting to note that Coulter and Chamberlain³ as far back as 1903 were able to differentiate between the female and male nuclei in the embryo sac on the basis of staining reactions without, however, realizing its significance.

From these observations we may further suggest that the division of the fertilized egg and central union nuclei is initiated by the re-introduction of DNA by the male nuclei. A similar explanation would also apply for the normal development of sea urchin eggs, where again only the sperm nucleus appears to contain deoxyribonucleic acid.

This view that DNA synthesis provides a regulating mechanism for nuclear activity has wider implications, of which the following may be mentioned.

(a) The reference by Darlington and Mather⁴ to the apparent development of vetch plants from lentils seed can now be seen in a different light. Only the male vetch nucleus contains the DNA necessary for further development on failure of fertilization, thus supporting the suggestion of androgenesis (male parthenogenesis).

(b) If the egg nucleus in the embryo sac never contains DNA, then it is difficult to understand how an embryo can develop in apomictic forms of reproduction where the male gametic nuclei play no part. There is some evidence, however, that the egg in apomictic forms of *Rubus*⁵ does contain DNA, and this may be associated with the fact that the embryo sac has developed directly from a somatic cell.

Further work is in progress in an attempt to establish more precisely the conditions which determine, on one hand, a discontinuance of nuclear division in the haplophase and, on the other, the resumption of division in the diplophase. It forms part of an investigation being carried out with the aid of a grant from the Agricultural Research Council and under the helpful guidance of Prof. P. T. Thomas.

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Chemical Composition of the Cell Wall of *Coccidioides immitis*

THE taxonomic position of *Coccidioides immitis*, the causative agent of coccidioidomycosis, has been debated for some time. It is evident from the method of endospore formation exhibited both in the parasitic phase and under certain cultural conditions^{1,2} that the mature *Coccidioides* cell is a sporangium and the endospores, sporangiospores. This indicates a probable relationship with the Phycomycetes^{3,4} and even possibly with the sub-class, Zygomycetes⁵. However, certain characteristics inconsistent with such a rela-

tionship, including the development of a richly septate mycelium and the absence of definite sporangia, present some taxonomic difficulties. Nevertheless, as noted by Emmons⁶, the sporangia of many of the Zygomycetes (for example, *Mortierella* and *Syncephalis*) present so many anomalies that *Coccidioides* may well find a place within the group. Frey⁷ has shown that the Phycomycetes may be divided into two distinct groups: the one having cellulose (Oomycetes), the other having chitin (Blastocladales and Zygomycetes) as skeletal material of their cell walls. Therefore, we thought it might be of interest to isolate and identify the non-water-soluble polysaccharide forming the skeleton of the cell wall of *C. immitis*.

A mixture of strains 2150 and 2200, both of which had been received originally from Dr. N. F. Conant, of Duke University Medical School, Durham, North Carolina, were grown at room temperature in shake culture in two half-litre Fernbach flasks in 1 litre of a tryptic digest of beef-heart medium containing 2 per cent glucose. The pH of the medium was 7.6. Massive amounts of growth were obtained on this medium in 3-5 days. The cultures were killed on the fifth day by autoclaving at 10-lb. pressure for thirty minutes and the growth was harvested by filtration. The material was washed repeatedly with distilled water on a Buchner funnel to remove the adhering medium and the mycelium was then dried in an oven at 90°-110° C.

The dried mycelium was extracted and oxidized as described by Scholl⁸. Debye-Scherrer diagrams of the isolated substance were very kindly prepared for us by Dr. W. Epprecht, Eidgenössische Materialprüfungs- und Versuchsanstalt, Zürich. These showed the typical powder pattern for chitin; there were no diffraction lines for cellulose. Nitrogen determinations confirmed these findings (N = 5.68, 5.85 per cent).

The isolation of chitin from the mycelium of *C. immitis* is consistent with Frey's findings in the Zygomycetes. It does not allow any definite conclusion as to the taxonomic position of this organism since chitin forms the skeletal material of fungi other than the Phycomycetes. Nevertheless, it does show that all fungi pathogenic for man and animals, whether they parasitize the keratin of hairs, skin or nails or the deeper tissues, have chitin as skeletal material of their cell walls^{9,10}.

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A Cyanocobalamin-Protein Complex from Sow's Milk and Desiccated Pig Stomach

We have already reported the partial purification from sow's milk and desiccated pig stomach of proteins which combine with cyanocobalamin and the vitamin B₁₂-like substances having different nucleotide groups¹. Purification of the protein from sow's milk whey was achieved by continuous electrophoresis on paper². Because of the labile nature of the protein itself, we found it easier to saturate the impure concentrate with cyanocobalamin labelled with cobalt-60 and to isolate the cyanocobalamin-protein complex. Purification of this complex by continuous electrophoresis on paper³ was followed by repeated fractionation with isopropyl alcohol at -5°. A recent preliminary note by Wijmenga, Thompson, Stern and O'Connell⁴, concerning a similar cyanocobalamin-protein from pig gastric mucosa, has prompted us to give a brief account of the properties of our substance isolated from sow's milk. Full experimental details will be published elsewhere.

The pink protein complex from sow's milk has the absorption spectrum shown in Fig. 1. The absorption at 278 mμ is largely due to protein ($E(1\%, 1\text{ cm.}) = 15.1$) and at 362 mμ to cyanocobalamin ($E(1\%, 1\text{ cm.}) = 5.7$). The total nitrogen (micro-Kjeldahl) is 16.1 per cent, and 1 mgm. of the complex contains 23.6 μgm. cyanocobalamin. From these figures, and assuming that one molecule of protein combines with one molecule of cyanocobalamin (mol. wt. = 1,300), the molecular weight of the protein would be 55,000. Qualitative examination of the hydrolysed complex shows an amino-acid pattern typical of proteins. Spectroscopic investigations, by the method of Holiday⁵, shows the rather high tyrosine content of 17.6 per cent. The presence of 7 per cent hexosamine suggests a glycoprotein rather than a mucoprotein.

Cyanocobalamin exists in the milk of the sow, woman, rat, goat and cow in bound forms. Gregory, Ford and Kon⁶ showed that sow's milk, but not cow's milk, combined with added cyanocobalamin. However, this procedure involved heating the milks with the assay medium. We have since developed an ultra-filtration method which shows that all these milks when raw and untreated can bind some added cyanocobalamin. Compared with sow's milk, the amount bound by the other milks is small. The electrophoretic mobility of the naturally occurring bound cyanocobalamin in all the milks and of the complexes formed by adding cyanocobalamin to these milks or to desiccated pig stomach was -3.1×10^{-5} cm.² V.⁻¹ sec.⁻¹ at pH 8.6, $\mu = 0.05$.

We have also investigated the mode of linkage between cyanocobalamin and the protein. Removal of the nucleotide and the most labile amide group from the cyanocobalamin molecule⁷ did not prevent its combination, but hydrolysis to the hexa- or hepta-acids⁸ gave a substance which could no longer be combined with the protein. The absorption curve (Fig. 1) with a peak at 362 mμ suggests that the complex contains cyano- rather than hydroxycobalamin. When ¹⁴CN-labelled cyanocobalamin was added to the partially purified binding protein from pig stomach and the whole was dialysed, no radioactivity could be detected in the dialysate. After purification (as described above), the pink protein complex still contained carbon-14 activity, indicating that the protein did not displace the cyanide during combination with the vitamin.

Specific groups on the molecule of the protein isolated from sow's milk were blocked by various reagents, and the capacity of the modified protein to bind cyanocobalamin was measured. Free -SH groups were not necessary for the binding. An -NH₂ or >NH group may be involved since, after reacting with fluorodinitrobenzene, the protein no longer bound cyanocobalamin. However, milder treatments for blocking -NH₂ groups, such as 3 per cent formaldehyde at pH 8 or an acetylation procedure using acetylthioethylacetamide at pH 10, did not interfere with the binding.

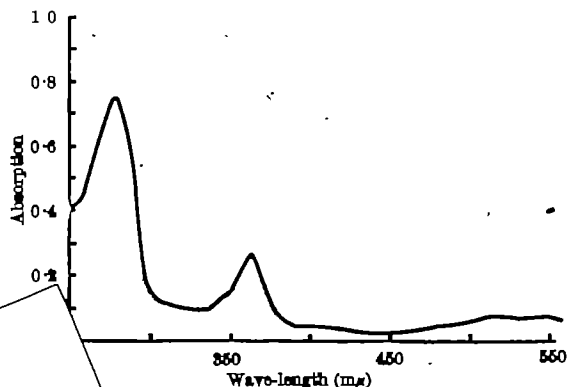
For a quantitative microbiological estimation of the cyanocobalamin in the complex, preliminary digestion with pepsin or trypsin is necessary. Enzyme digestion converts the microbiologically inactive cyanocobalamin complex into a form fully active for *Lactobacillus leichmannii* when heated with the assay medium but having only 20 per cent of this activity when assayed unheated. Furthermore, ultra-filtrations of the unheated and heated digests showed that not more than 10 per cent of the total cyanocobalamin had become ultra-filtrable. Since cyanocobalamin itself can be ultra-filtered quantitatively, it appears possible that the digest contains peptide conjugates of cyanocobalamin.

There seems no doubt that the substance isolated by us from sow's milk is very similar to the cyanocobalamin-protein isolated by Wijmenga *et al.* from hog gastric mucosa. The only discrepancy is that we find that 1 mgm. of the complex contains 23.6 μgm. cyanocobalamin, whereas Wijmenga *et al.* find only 12.3 μgm.

We wish to thank Dr. E. Lester Smith (Glaxo Laboratories) for gifts of ⁶⁰Co cyanocobalamin and ¹⁴CN cobalamin and the cyanocobalamin hydrolysis products, and Dr. S. K. Kon for his advice and interest in this work.

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Absorption curve of cyanocobalamin-protein complex in aqueous solution (0.5 mgm./ml.)

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Odour and Chemical Constitution

NOTHING is known of the mechanism by which small amounts of odorous material can trigger nervous impulses leading to smell sensations, because the characteristic odour of a substance has not hitherto been securely correlated with any other characteristic property of its molecules.

Some years ago, G. M. Dyson¹ concluded that odour must be related to a characteristic molecular vibration pattern, and he assigned certain odours to certain Raman frequencies ("oemic frequencies") in the general range 1,500–3,000 cm^{-1} . In this region, Raman lines are correlated strongly with particular functional groups (OH, SH, OO, etc.), so that if odour could be correlated with these frequencies it could equally well be correlated with the corresponding functional groups and there would be no need for a vibrational theory of odour. On the other hand, Raman lines below about 1,000 cm^{-1} appear to depend upon the whole configuration of the molecule more than on the constituent groups. Odour also appears to depend more on the whole configuration of the molecule, so that a correlation of odour with vibration would be more reasonable at low frequencies than at high. Moreover, the Planck formula shows that only normal vibrations with a wave number considerably less than 1,000 cm^{-1} have a significant probability of being active at body temperature.

Dyson's 'oemic frequencies' are therefore excluded on both chemical and quantum grounds, and any correlation between odours and molecular vibration patterns must be looked for at frequencies below about 700 cm^{-1} corresponding to absorption in the infra-red beyond about 15 microns. This region does not seem to have been previously searched for odour correlations.

A panel of fifteen observers was used to select sixteen compounds with an odour resembling that of nitrobenzene. Of these compounds, all but one (nitrothiophene) were benzene derivatives, and all but one (isocoumarane) had multiple bonds in the side-chain conjugated with the ring. Apart from this general similarity of type, the compounds had such varied functional groups as nitro, nitrile, aldehyde, ketone, ester, etc. When the low-frequency Raman shifts of these compounds were scrutinized, there was some evidence of a statistically significant correlation between the odour and the pattern of the Raman lines. This work is being reported in detail elsewhere.

The Raman frequencies below 800 cm^{-1} of three of these compounds (nitrobenzene, nitrothiophene and benzonitrile) are shown in Fig. 1. A search of the literature for substances with unrelated structures but similar Raman spectra showed that butyronitrile met the requirements fairly well. In the opinion of six observers, its odour is somewhat almond-like. The successful selection at the first attempt of an aliphatic compound with the same general type of odour as a group of sixteen aromatic substances is

something which no other theory of the physical basis of odour would enable one to do.

A correlation of odour with the pattern of molecular vibrations may therefore be possible if the frequency-range below 1,000 cm^{-1} is studied. The Raman effect is at the present the most convenient tool for the purpose.

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¹ Dyson, G. M., *Perf. Essenc. Oil Record*, 18, 456 (1928); 23, 13 (1927); *Chem. and Indust.*, 16, 647 (1938).

In the early 'twenties when the first work on this aspect of oemics was under active consideration our knowledge of the Raman lines below 1,000 cm^{-1} was rudimentary, and while correlation between structural groups and the higher frequencies is now fairly well established, the need for a vibrational theory of odour does not, in my view, automatically disappear.

The interesting results established by Mr. R. H. Wright prove, if they prove anything, that the original hypothesis correlating odour specificity with molecular vibration was sound in principle, but that I was wrong in assuming the frequencies concerned to be those in the higher Raman ranges. He has made a valuable advance in this field by focusing attention on the significance of the lower frequencies; they relate to the molecule as a whole and this, in itself, is an attractive development of the original thesis. There are, however, several groups of compounds which must come under review before the theory can be fully accepted: I refer in particular (a) to the group $R.C_6H_4.NCS$ which, when $R=H$, $o-CH_3$, or $o-Cl$, retains the mustard-like odour associated with allylthiocarbimide, but when $R=CH_3$, $p-Cl$, $p-OCH_3$, acquires a strong odour resembling anisaldehyde (on *passant*, 4-cyanophenylthiocarbimide has a strong almond component to its odour); (b) the 'camphor-like' groups in which such diverse substances as camphor, hexachloroethane, benzene hexachloride and perchloronaphthalene have closely related odours; and (c) the 'tea-rose' thiazoles of Bogert, which have odours reminiscent of phenyl acetaldehyde or the esters of phenylacetic acid.

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Effect of Flight on Behaviour of *Aphis fabae* Scop.

AFTER a preliminary period of quiescence newly moulted alate alienicolae of *Aphis fabae* Scop. take flight, in suitable physical conditions, whatever the quality of the host they are on. When they alight on a host plant after a sufficient flight they do not take off again immediately¹ as they do before sufficient flight², and they may settle down and bear young. Moericke³ thought that this indicated two phases in the life of alate aphids, the *Zugphase* and *Befallsphase*, and Müller and Unger⁴ attributed the transition from one to the other to exhaustion. The following experiments show that the change can be brought about by flight itself, and that it is not necessarily permanent.

The experiments were carried out in a greenhouse and the laboratory at temperatures between 20 and

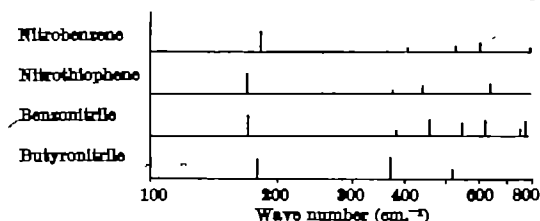


Fig. 1

30° C., on alate from laboratory cultures and natural infestations of broadbeans (*Vicia faba* L.).

The aphids were given flight exercise by attaching them by the thorax to small pins with water-colour paint, and also by permitting untethered flight in the greenhouse. In this way it was shown that a very short flight of an average of about 20 sec. was sufficient to result in the changed behaviour when the aphids were returned to their host plants. The change could be induced by longer periods of activity other than flight, as when the aphids were kept in the light for several hours in a narrow glass tube in which they were able to crawl but unable to fly.

Aphids alighting on a host plant after sufficient flight wander about for several minutes and whether they stay or leave is influenced by the host suitability. Flown aphids placed on highly suitable hosts (6 cm. high broadbean seedlings) settled and remained there until they had lost the ability to fly; on less suitable hosts (isolated mature broadbean leaves) they took off again. Aphids placed on young plants of broadbean 1 metre high showed a considerable variation in behaviour after wandering; a few remained but most of them took off again, this agreeing with the field observations of other workers^{1,4}.

Parturition occurs soon after the aphids settle down on seedlings after flight, or are confined after flight on mature leaves in the dark; its initial rate is influenced by the state of development of the embryos and not by the quality of the host⁴. Nor is it necessary for the aphids to feed for them to stay and bear young, contrary to the assumption of Kennedy and Booth⁴. When unflown aphids are confined on host plants by darkness from flight maturity, embryonic development continues but no larvae are born for two days or more, although several hours after reaching flight maturity the ovaries contain 8-12 fully formed embryos. Such aphids when flown commenced to bear young within an hour of settling, and a number of larvae were then born at half-hourly intervals; an average of 9.0 ± 0.24 larvae were born overnight ($n = 77$). Aphids flown as soon as they reached flight maturity gave birth to an average of only 3.4 ± 0.20 larvae overnight ($n = 50$). Anything, therefore, which delays the initial take-off of the aphids from their parent host plant will help to reduce the length of their flying life by increasing the number of larvae born in the first batch and so hastening the processes leading to the autolysis of the flight muscles¹.

Young aphids which have alighted on an unsuitable host or have been disturbed while feeding on a suitable host may take off again, and a further short flight is necessary before they will settle down to feed and reproduce.

This work will be published in detail elsewhere.

I am indebted to Dr. C. G. Johnson and Dr. J. S. Kennedy for reading this communication in draft.

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Rothamsted Experimental Station,
Harpenden, Herts.
Jan. 26.

¹ Müller, H. J., *Zeitschr.*, **23**, 176 (1953).

² Moericke, V., "Zur Lebensweise der Pflanzenschädler (*Myndus persicus* Sulz.) auf der Kartoffel", thesis, Univ. of Bonn (1941).

³ Müller, H. J., and Unger, K., *Zeitschr.*, **23**, 206 (1953).

⁴ Kennedy, J. S., *Nature*, **166**, 1024 (1950).

⁵ Kennedy, J. S., and Booth, C. O., *Ann. App. Biol.*, **38**, 25 (1951).

⁶ Kennedy, J. S., and Booth, C. O., *Ann. App. Biol.*, **37**, 451 (1950).

⁷ Johnson, Bruce, *Nature*, **172**, 813 (1953).

The Marshes of the Medway Estuary In Romano-British Times

THE view has long been held that the Romano-British pottery and clay fire-bars which occur at various levels in the Scrobicularia Clay (that represents the bulk of the estuarine deposits which compose the marsh) constitute the output and appurtenances of contemporary potters' kilns which had been sited somewhere on the marsh.

The makers' stamps on the pottery cover a period ranging from the middle of the first century A.D. to the third quarter of the second century; though the greater number of the stamps fall within the Hadrian-Antonine phase, namely, between A.D. 117 to A.D. 161.

The present Ordnance Survey maps (scale 6 in. to 1 mile) of the area in question set across many of the saltings the following legend: "Roman Potteries (Site of)". Indeed, that of "Kent" (Sheet XX, N.E. Edition, 1908) shows no less than four such sites.

As the result of twenty-five years study of the deposits of the Uphurh Marsh, I write to suggest that this area could not possibly have supported a Romano-British pottery-making industry. The evidence upon which this suggestion is founded is two-fold—one geological, the other archaeological. There is overwhelming proof that shortly after the commencement of the second century A.D. the sea had obtained complete control over the whole district and that Scrobicularia Clay had been universally deposited to the level of 5 ft. above O.D.

At this stage Romano-British man occupied the intertidal surface of the marsh-clay for the purpose of making salt. This industry is reflected in the occurrence over widespread areas of a specific deposit containing briquetage, clay fire-bars which were required for the process of salt-making, broken pottery and animal bones.

Over this accumulation of refuse—which varies in thickness from 6 in. to 3 ft.—the sea continued its deposition of marsh-clay up to a height of 11 ft. above O.D., which forms the highest level of the present-day salting surface.

A detailed description of the various archaeological horizons which occur in these estuarine deposits will be furnished in a paper to be read later in the year.

J. P. T. BURCHELL

Falcon Cottage, Fawke Common,
Sevenoaks, Kent. Jan. 16.

Zoological Nomenclature

NOTICE is hereby given that the International Commission on Zoological Nomenclature has under consideration the following case involving the possible use of its plenary powers: *Caenites* Buckman, 1925 (Class Cephalopoda, Order Ammonoidea), proposed suppression of. Full particulars of this case are given in Part 12 of volume 6 of the *Bulletin of Zoological Nomenclature*.

Any comments on the above case should be sent to me as soon as possible and, in any event, should be dispatched in time to reach me not later than August 26, 1954, when voting on this case will begin.

FRANCIS HEMMING

(Secretary to the International Commission
on Zoological Nomenclature)

- 28 Park Village East,
Regent's Park, London, N.W.1.

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Sunday, May 2—Friday, May 7

SOCIETY OF DAIRY TECHNOLOGY (at the Northern Counties Hotel, Portrush, Co. Antrim, Northern Ireland)—Summer Meeting.

Monday, May 3

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. T. R. Armstrong: "Northern Sea Route".

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION AND FATS AND OILS GROUP (in the Chemical Society's Rooms, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Prof. T. P. Hilditch, F.R.S.: "The Fats: a Story of Nature's Art".

Tuesday, May 4

INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS, LONDON CENTRAL (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Annual General Meeting; Mr. D. W. Morris, Mr. W. G. Shadlock and Mr. R. W. Thurlow: "Short-Wave Directional Aerial Systems".

UNIVERSITY OF LONDON (in the Metallurgy Theatre, Imperial College of Science and Technology (Royal School of Mines), Prince Consort Road, London, S.W.7), at 5 p.m.—Prof. P. G. Kihlstedt (Stockholm): "The Economical Adaptation of the Beneficiation Processes". (First of four lectures on "Some Important Points in the Utilization of Low-Grade Ores by Mineral Dressing". (Further lectures on May 6, 10 and 11).)

SOCIETY OF CHEMICAL INDUSTRY, CORROSION GROUP (in the Lecture Theatre of the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Annual General Meeting, followed by a discussion on "Corrosion and Design".

Wednesday, May 5

ROYAL MICROSCOPICAL SOCIETY (at Tavistock House South, Tavistock Square, London, W.C.1), at 11 a.m.—Symposium on the "Gold Apparatus".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Commander C. G. Mayer: "Colour Television".

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Commandant G. S. Houbt: "13,000 Feet Under the Sea".

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. J. R. Partington: "Some Aspects of Seventeenth-Century Chemistry". (Further lectures on May 7 and 10).)

BRITISH INSTITUTION OF RADIO ENGINEERS, LONDON SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 6.30 p.m.—Mr. P. M. Ratcliffe: "Microwave Measuring Equipment".

SOCIETY FOR ANALYTICAL CHEMISTRY (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific report.

Thursday, May 6

LABORATORY ANIMALS BUREAU (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 10.45 a.m.—Symposium on "The Design of Animal Houses".

PHYSICAL SOCIETY, OPTICAL GROUP (at the Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Dr. R. H. Kay: "A Spectrophotometer for Estimating Ozone in the Atmosphere"; Mr. D. F. Feder: "Optics at the Bureau of Standards".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. J. H. Quastel, F.R.S.: "Soil Metabolism" (The Leeuwenhoek Lecture).

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Peter Scott: "A Population Study of the Pink-footed Goose" (Illustrated by a film taken in Iceland). Dr. W. J. L. Sladen will give a preliminary report of the flora of the area, illustrated with coloured slides.

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Mr. F. S. Collier: "The Forest Resources of the Colonial Territories and their Management".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Dr. R. H. Marinko: "The Story of the Iodoquinoline Alkaloids" (Centenary Lecture).

SOCIETY FOR VISITING SCIENTISTS, LTD. (at 5 Old Burlington Street, London, W.1), at 7.45 p.m.—Discussion Meeting: "World Population—Views from Brazil, India and the United States". Chairman: Prof. L. Dudley Stamp, O.B.E. Speakers: Prof. H. O'Reilly Sternberg, Prof. George Kurlyan and Prof. George B. Cressy.

Thursday, May 6—Saturday, May 8

INSTITUTION OF CHEMICAL ENGINEERS, CHEMICAL ENGINEERING GROUP of the SOCIETY OF CHEMICAL INDUSTRY (joint conference with the ROYAL INSTITUTION OF ENGINEERS (Chemical Engineering Group) of the NETHERLANDS and the ROYAL NETHERLANDS CHEMICAL SOCIETY (Section for Chemical Technology, at Koninklijk Instituut voor de Tropen, Mauritskade, 63, Amsterdam))—Conference on "Oxidation Processes".

Friday, May 7

ROYAL INSTITUTION OF CHEMISTRY (joint meeting with the MICRO-CHEMISTRY GROUP of the SOCIETY OF PUBLIC ANALYSTS, in the Zoology Lecture Theatre, The University, Reading), at 7.45 p.m.—Symposium on "Microchemical Methods in Biochemistry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. W. H. Thorpe, F.R.S.: "The Analysis of Bird Song".

Saturday, May 8

NUTRITION SOCIETY (in the Lecture Theatre, Department of Biochemistry and Physiology, The University, Glasgow), at 11 a.m.—Symposium on "Nutrition and the Liver". Chairman: Prof. J. N. Davidson.

SOCIETY FOR ANALYTICAL CHEMISTRY, WESTERN SECTION (at the Technical College, Newport, Mon.), at noon—Inaugural Meeting. Dr. D. W. Kent-Jones: "Alcohol Determination and its Medical Legal Aspects".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

NUCLEAR POWER ENGINEER (with a degree in physics or electrical engineering, and a knowledge of atomic physics, thermodynamics and metallurgy, and good practical experience), to organize and lead a new branch of the Chief Engineer's Department, which initially will be engaged on design studies of thermal reactors and the conversion of the liberated heat into electricity, and later will be required to design, construct and operate nuclear power stations—The Director of Establishments, British Electricity Authority, Winsley Street, London, W.1, quoting AB/476 (May 5).

ASSISTANT LECTURER (graduate or about to graduate, and with special qualifications in palaeontology and stratigraphy) in GEOLOGY—The Registrar, King's College, Strand, London, W.C.2 (May 8).

LECTURER in the DEPARTMENT of GEOLOGY and MINERALOGY—The Secretary, The University, Aberdeen (May 8).

LECTURERS or ASSISTANT LECTURERS in CIVIL ENGINEERING or SURVEYING, PHYSICS, VETERINARY MEDICINE and PHARMACOLOGY, at the University College of Khartoum, Sudan—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 9).

ASSISTANT LECTURER in PHYSICAL-ORGANIC CHEMISTRY, and a LECTURER in THEORETICAL PHYSICS—The Registrar, Queen Mary College, Mile End Road, London, E.1 (May 10).

LECTURER (with an honours degree in chemistry, and experience in industry, teaching or research) in CHEMISTRY—The Principal, Wigan and District Mining and Technical College, Wigan (May 10).

BIOCHEMIST to work on the proteins of eye tissues with particular reference to pathological conditions—The Secretary, Nuffield Laboratory of Ophthalmology, Walton Street, Oxford (May 14).

CHEMIST/BACTERIOLOGIST (with an honours degree in chemistry or member of the Royal Institute of Chemistry, and preferably with waterworks experience) in the Christchurch laboratory of the West Hampshire Water Company—The Chief Engineer, West Hants Water Company, 21 Stour Road, Christchurch (May 17).

JUNIOR FELLOW in APPLIED MATHEMATICS—The Registrar and Secretary, The University, Bristol (May 17).

SCIENTIST, Grade 3 (with an honours degree in mathematics or statistics) on the London Headquarters Staff of the Director of Scientific Control, for work which mainly consists of the design of experiments and the analysis of experimental data obtained by the Board's scientists in the coalfields—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/771 (May 17).

ASSISTANT LECTURER (with either a special qualification in connection with the mechanical testing of metals or experience in the chemical aspects of metallurgy) in METALLURGY—The Registrar, The University, Manchester 13 (May 22).

LECTURER in AGRICULTURAL BOTANY at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 22).

LECTURER in THEORETICAL PHYSICS—The Registrar, University College of North Staffordshire, Keele, Staffs (May 22).

RESEARCH FELLOW in CHEMISTRY—The Registrar, University College, Singleton Park, Swansea (May 22).

NUFFIELD RESEARCH FELLOW in PHYSICS, a RESEARCH PHYSICIST, and a RESEARCH ASSISTANT, for work in connection with the cyclotron and synchrotron programmes of the Nuffield Research Laboratory—The Registrar, The University, Birmingham (May 20).

LECTURER in EDUCATION at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

LECTURER (preferably with qualifications in applied mathematics and/or engineering mathematics) in MATHEMATICS, at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, May 31).

LECTURER (with British university qualifications, or equivalent, and some experience in teaching geology in a University Department of Geology and Geography) in GEOLOGY, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (May 31).

READER in APPLIED MATHEMATICS at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (May 31).

ASSISTANT LECTURER (graduate in physics, engineering or chemical engineering, and preferably with experience in the food industry)—The Registrar, National College of Food Technology, Cranwood Street, London, E.C.1.

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BRITISH TELECOMMUNICATIONS RESEARCH Ltd., a Company associated with the Automatic Telephone and Electric Co. Ltd. and British Insulated Callender's Cables Ltd., has a vacancy for a senior engineer for work on the development of specialized test equipment for telecommunication systems. There is a superannuation scheme and the Company works a five-day week.—Application should be made to the Director of Research, British Telecommunications Research Ltd., Taplow Court, Taplow, Bucks., giving age and full details of education, qualifications, experience and approximate salary required.

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SENIOR ANALYTICAL CHEMIST, F.R.I.C., with experience in food chemistry, required to take charge of the Association's Analytical and Microbiological Assay Section. Some knowledge of bacteriology would be an advantage. Commencing salary of the order of £1,000 per annum, according to age and experience. F.R.S.U. pension scheme.—Apply, as soon as possible, to the Director of Research, British Baking Industries Research Association, Chorleywood, Herts.

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Further information and forms of application may be obtained from the Registrar, to whom the completed forms must be returned not later than July 1, 1954.

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Applications are invited for the above Fellowship, which is of the annual value of £300 and is tenable for two years. Candidates should be graduates in science of at least one year's standing of a British university. The successful applicant will be required to undertake research in chemistry or physics (excluding nuclear physics) in the University of Glasgow. Appointment will date from October 1, 1954.

Applications should be lodged with the Clerk of Senate, The University, Glasgow, W.2, not later than May 31, 1954.

UNIVERSITY COLLEGE OF HULL RESEARCH STUDENTSHIP

Applications are invited for a Research Studentship of the value of £300 per annum in the Department of Zoology, dating from October 1, 1954, normally tenable for two years. A Research Student will be expected to undertake a limited amount of demonstratorship.

Particulars may be obtained from the Registrar, to whom applications in triplicate should be sent not later than May 17, 1954.

C. MEGGITT,
Registrar.

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G. R. HANSON,
Registrar of King's College.

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Applications should be forwarded to the Principal, Royal Holloway College, Englefield Green, Surrey, not later than June 8, 1954. The awards will be made in the latter part of July, 1954.

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The British Rayon Research Association offers a Research Scholarship of £300 per annum, plus college fees, tenable for three years, to enable graduates in physics or physical chemistry (first- or top-second-class honours) to work for the degree of Ph.D. of the University of Manchester. The successful candidate will be expected to work in the Department of Textile Chemistry of the College, under the direction of W. W. Barlow, D.Sc., F.Inst.P., on rheological problems connected with the interaction of water with assemblages of hygroscopic fibres.

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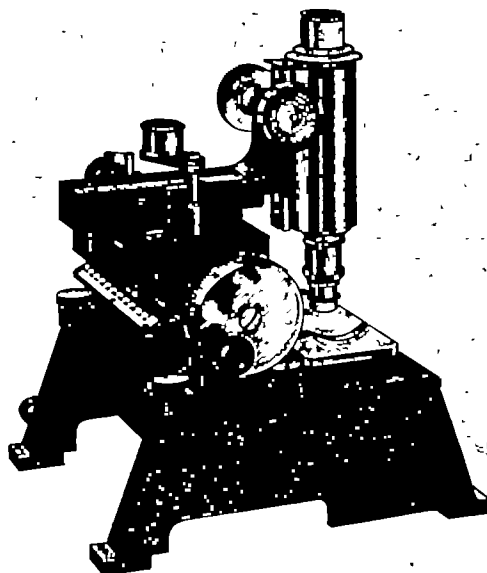


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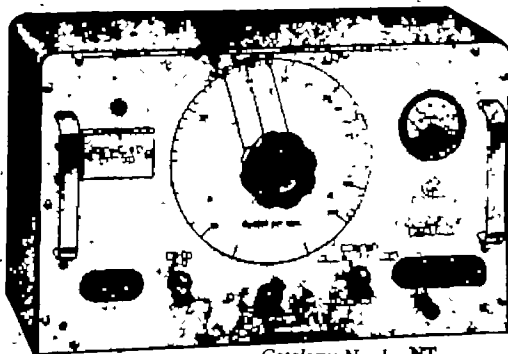
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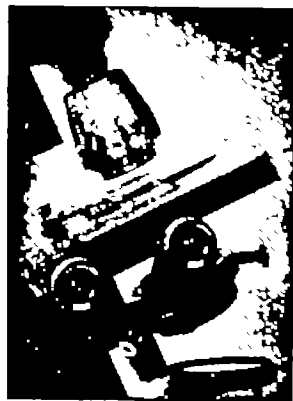
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VOL 173, No. 4410

SATURDAY, MAY 8, 1954

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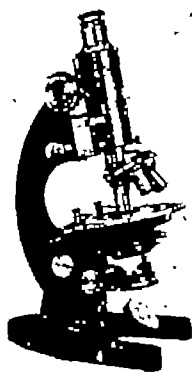
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NATURE

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SECRECY AND SECURITY IN ATOMIC RESEARCH

THE recent debates in Parliament on the Defence Estimates, and the "Statement on Defence, 1954"* on which they centred, were marked by a candour which has often been absent from such debates and by a keen appreciation of the need for informed public discussion of the broad issues, though it was impossible, for security reasons, to discuss details or the magnitude of the effort in particular directions which is being undertaken in Great Britain. In that of atomic energy, for example, Dr. J. B. Conant has expressed the opinion that no full public discussion is possible within the foreseeable future. The subsequent hydrogen bomb developments may well, however, enforce somewhat fuller public discussion, at least on such issues as the apportionment of resources between research and production in different fields of defence and between defence research and civilian research. Moreover, quite apart from the implications of President Eisenhower's proposals of last December for an international atomic pool under the United Nations, and his subsequent message to Congress on February 17 asking for changes in the Atomic Energy Act of 1946 to facilitate wider co-operation with the allies of the United States in the interchange of information concerning the use of atomic weapons, the processing of atomic raw materials, reactor development, production of fissionable materials and related research and development, strong support for more freedom in the exchange of information has been forthcoming from responsible quarters inside as well as outside the United States.

In an article in *Foreign Affairs* last summer, Dr. J. R. Oppenheimer, formerly director of the Los Alamos Laboratory, discussing atomic weapons and American policy, urged more candour in making available to the public the information necessary for informed discussion of the factors which limited the country's choice of action. That is as essential in other countries as in the United States if governments are to be assured of the firm support of intelligent public opinion in the difficult decisions they are called upon to take. This argument is well illustrated in the introduction to the Statement on Defence, 1954. Dr. Oppenheimer equally stressed the need for more candour on the part of the United States in dealing with its major allies. Here he referred both to technical collaboration and to the military collaboration, for which both General Bradley and General Collins had pressed as a precondition of effective planning and successful defence of Europe. Dr. Oppenheimer also argued that more candour is an essential factor in securing public co-operation in the measures of civil defence required to moderate the dangers from atomic weapons or other means of enemy attack on the civil population, and the soundness of his arguments is well indicated in the reactions of some local authorities as well as of individuals in Great Britain

* Statement on Defence, 1954. Pp. 23. (Cmd 9075.) (London: H.M. Stationery Office, 1954.) 1s.

to the statements in the press regarding the hydrogen bomb explosions of March 1 and later.

Mr. Gordon Dean, former chairman of the United States Atomic Energy Commission, in his subsequent book, "Report on the Atom", takes a similar view. Mr. Dean believes that, in the absence of informed public discussion, the United States decision to build up a stockpile of atomic bombs, which became the most important single factor in planning its strategic defence, resulted in the stockpile being carefully concealed so that nothing could be done with it except under the most extreme conditions and with much soul-searching at home and a loss in reputation for morality abroad. This situation gave the U.S.S.R. much more freedom of action in the post-war world than they would otherwise have had, and although Mr. Dean is a convinced believer in the deterrent value of the atomic stockpile, he gives no high place to secrecy in his proposals for improving the security of the United States and the free world. Progress in science, he recognises, has no international boundaries or special environments, and leadership in the atomic field will be maintained by achievement, not by a cloak of secrecy.

This welcome reminder that security and secrecy are not synonymous—and may even be inconsistent—comes, not from a scientist but from a lawyer-administrator, who sees as the goal over the next few years a wide base of co-operation between the scientists and engineers of the United States and Great Britain in the field of atomic energy, conducted in such a way that the Soviet programme is not advanced. There is thus already much support for President Eisenhower's proposals from responsible opinion, both civil and military, in the United States, and it is desirable that discussions of defence policy and of the functions of the Atomic Energy Corporation Bill should be so conducted as to put no fresh obstacles in the way of Anglo-American co-operation and the interchange of information. For the same reason, scientists should do what they can to put discussion of hydrogen bomb developments on a factual basis. Calm judgment and clear thinking, not partisanship or passion, are the way to security.

In his article referred to earlier, Dr. Oppenheimer agrees with Dr. Conant that to-day public opinion does not exist in the field of atomic energy; he pleads particularly that knowledge of the characteristics and probable effects of atomic weapons, of—in rough terms—the numbers available, and the changes that are likely to occur within the next few years, and our general estimate of where a potential enemy stands, are not among the things to be kept secret.

The Civil Estimates for 1954–55 disclose for the first time the magnitude of the national expenditure in Britain on the development of atomic energy, though that on atomic weapons is still concealed within the Service estimates and those for the Ministry of Supply. Nevertheless, the Statement on Defence is a first tentative step towards a public discussion in general terms and itself points to some of the essential questions to be asked, while others emerged in the debates in the House of Commons.

First, the Statement emphasizes the heavy burden on the economy of Britain imposed, not merely by the magnitude of the Defence Estimates themselves but also by the continuing need to devote to defence production a substantial part of the output of the engineering industry. It is thus still necessary to hold a careful balance between the demands of defence and those of other sectors of the economy and, in particular, to ensure by close co-operation with our partners that our share of the common burden does not impose an undue strain on our balance of payments: "Our armed forces cannot, in these circumstances, be provided with all those things which ideally they should have".

That being so, there are two fundamental questions to ask. The first concerns the effectiveness of co-laboration with our partners. There should be no possibility of the cost of security being confused with the cost of independence. Cool, impartial public discussion, when well informed, is a real safeguard against the duplication of research and prototypes, and a powerful stimulus to politicians to create the political conditions which further cheaper and more efficient defence.

The second question relates to the balance of the national effort in Britain, both that between defence and civilian research and development, and that between conventional and new and unconventional weapons. It is here that the biggest problems are now emerging, as the Statement on Defence indicates; and while public discussion could help at least in ensuring support for the difficult decisions which must be taken, it can only help if such discussion is serious and responsible as well as informed. The defence policy outlined is based on the prevention of war and accepts the necessity of keeping our present lead in technical development to offset weakness in man-power. Only by implication is it recognized that Great Britain's foreign policy should be in keeping with the resources available to support that policy, and one of the most striking features of the references to man-power is the absence of any reference to the point made by Sir Godfrey Ince in his paper to the Manchester Statistical Society last year regarding the use of man-power: both in industry and in the Services it is essential that the most fit and active should not be employed on tasks or duties which could be done as well by older and less active men. The point was indeed taken up by speakers in the debates in Parliament, but in respect of the employment of women in the Services.

There may, of course, be room for argument as to the respective roles of the three Services in the overlapping and conflicting tasks arising out of the policy set forth in the White Paper. As to the situation created by the atomic weapons which are already being delivered to the Forces, and by the guided missiles, which have reached an advanced stage of development, the major clash of opinion arose as to the change which should be made in the direction and balance of the research effort of Britain. Moreover, the White Paper itself points out that the balance between new and conventional weapons can only be decided over a period of years in the light of

the situation as it develops, and of the studies in the problems of tactics and training created by the new weapons which are proceeding both in the United Kingdom and under the North Atlantic Treaty Organization. The hope is expressed that these studies will gain in realism and effectiveness as a result of President Eisenhower's request to Congress for legislation permitting the release of more information on the use and effects of nuclear weapons.

Summing up, it is clear that the central theme is the need for the freest exchange of information consistent with national security. At different levels, different criteria will obviously have to be applied. So far as the general public is concerned, sufficient general knowledge relating to atomic energy and to atomic weapons should be made available to enable people to appreciate not only the magnitude but also the limitations of recent developments; by these means alone can a reasoned and balanced view of affairs be achieved. At more specialized and technical levels, the amount of information which can be exchanged must be assessed on a different basis; but secrecy for its own sake has always been a friend of wastefulness, inefficiency and duplication such as can ill be afforded at the present time.

THE NANYANG UNIVERSITY, SINGAPORE

THE proposed Chinese University in Singapore (called "Nanyang" after the Chinese name for South-East Asia) stems immediately from the separate system of Chinese schools in Malaya, but more basically from a deep urge in the Malayan Chinese to preserve their cultural independence. Throughout the country there exist, side by side, English schools (primary and secondary) and Malay, Chinese and Tamil vernacular schools. The latter have far more pupils, but only the Chinese schools constitute a system paralleling the English schools right up to secondary level, and also largely independent of Government help and control. Their main medium of instruction is Chinese, and the English which all their senior pupils learn is not usually enough to qualify them to enter the country's established University, the University of Malaya, where English is the medium of instruction and academic standards are those of the universities of the United Kingdom. Most of its students are indeed Chinese; but they nearly all come from English secondary schools.

Boys and girls from Chinese schools seeking a university education have hitherto commonly gone to China. To-day that has obvious difficulties and disadvantages. Education in China is education in Communism. Those who go there find it hard to return and may be lost to their families and to Malaya. More and more are thus left with no clear avenue to any university. Actual numbers are small; Chinese school pupils are said to total 400,000 against 211,000 in English schools; but whereas there

were 4,339 in English School Certificate classes last year, the corresponding Chinese school classes had only 418, of whom but a fraction will actually seek a university education.

However, the problem, if far smaller than sometimes suggested, is real, and it was primarily to solve it that a group of wealthy Chinese proposed last year to create a new Chinese university in Singapore. They spoke also of providing a centre for the study of Chinese culture and of supplementing the work of the University of Malaya by teaching subjects not yet offered there; and, in answer to a charge of communalism, they proposed to cater for Malayan residents of other races, too.

An initial fund has now been raised, a site decided upon, building plans prepared and—a most important step—a chancellor and a vice-chancellor selected, in the persons of Dr. Lin Yu Tang and Dr. Robert Lim. With one initial promise of 5,000,000 dollars and smaller donations and promises, funds available may be upwards of 7,000,000 dollars local currency (say £800,000). That is no more than a start towards the cost of a modern university; for comparison, the University of Malaya already costs about £650,000 per annum, and the cost of rebuilding it on a new site was put at £17,000,000.

The chancellor is to be the active chief executive, and many decisions may be postponed until Dr. Lin arrives (probably in September) and familiarizes himself with an atmosphere hitherto strange to him. Meanwhile, no academic appointments have been announced; legal authority to issue degrees has still to be obtained; the steps to be taken to guarantee their standard have still to be defined; and no formal announcement has been made of the basis of admission of students. None the less, teaching is planned to start early in 1955, using temporary or borrowed buildings. Initially there are to be Faculties of Arts and Science only and, rather surprisingly, teaching is to be largely in English. The first is a wise decision; it would have been over-bold to tackle fields such as engineering, which the University of Malaya has found too difficult hitherto but will in any event be entering soon.

Certain questions inevitably arise. First, could not a ladder to university education be more easily provided by bringing the Chinese school pupils up to the standards in English language of the University of Malaya, or by giving some teaching in the University in Chinese? The problem is not solely one of language, for there are other marked differences existing in the basic educations given in the English and the Chinese schools; but possibilities of adaptation or extension of teaching in their senior classes or of otherwise bridging the gap between them and the University of Malaya are under active examination. However, the sponsors of the Nanyang University decided that only a quite separate institution could serve their purposes.

Secondly, is the new institution needed for the study of Chinese culture and literature? Long delays had raised doubts whether the University of Malaya would ever give reality to the Department of Chinese Language it had long possessed on paper; but the

appointment last summer of a head of that Department and the purchase of some 80,000 volumes as the basis of a Chinese library have made clear that it does not intend to neglect that field.

Thirdly, what will be the value to the practical-minded student of a Nanyang University degree? Much will depend on the recognition given locally, for example, for Government appointments, and on whether good English continues to be essential in the professions and the other higher appointments to which the local graduate aspires. If the new University offers no reliable avenue to local employment, will it prove an effective counter-attraction to a university education in China, offering a definite avenue to employment there? The answer may depend on whether the Chinese school pupil really wants an education for China or an education for Malaya.

Fourthly, can any university in Malaya to-day establish and maintain itself without constant re-inspiration and reinforcement from outside, as the University of Malaya is inspired and reinforced by its close contacts with the Commonwealth universities? If not, where is the Nanyang University to find such reinforcement outside China?

Hitherto the Chinese in Malaya has had to choose, for his higher education, between a Western system in Malaya or a Chinese system in China. The Nanyang University seeks to offer the alternative of a system geographically in Malaya but culturally inspired by Chinese thinking. It is yet another mark of the great and vital interest taken in education by people of Chinese race, and an interesting experiment in a mixed society of confused cultural loyalties and linguistic habits; but it fits very uneasily with the political aspirations of Malaya to a united and integrated nationhood.

FOUNDATIONS OF MODERN PHYSICS

A History of the Theories of Aether and Electricity The Modern Theories 1900-1926. By Sir Edmund Whittaker, F.R.S. Pp. xi+319. (London: Thomas Nelson and Sons, Ltd., 1953.) 32s. 6d. net.

IF a younger physicist is to review a new book on the history of physics, and if the author of the book has grown up with all the events about which he is writing, then the reviewer is in a difficult situation. Unlike the author, he has not grown up with the material, but has only absorbed the latest stage of the physical theories during his student days and subsequent work, so that he is not familiar with many details in the historical development of even the past fifty years. To review such a book and comment on the historical correctness and completeness of the work, he must study the history of science, and only then is he in a position to make some criticisms. But in regard to this book by Sir Edmund Whittaker, a reviewer must do much more: it warrants a thorough study of physical literature since 1900 before one has the right to make such a statement as: "I do not agree with this or that" or to put one's finger on a mistake.

If one asks why has such a book been written, the answer could be: to spare other people the necessity of reading the enormous amount of scientific papers of the period in question in order to understand the historical evolution; and it is in the attainment of this objective that I feel competent to comment. Before doing this, however, let me return for a moment to the question of historical accuracy. Extrapolation is a well-known scientific technique, and I think it is possible by means of extrapolation to judge even on this question. One need read only a few pages of the book to sense the thoroughness and conscientiousness of the whole work. Furthermore, one will note that no statement is made without being justified by at least one quotation, the total of which I estimate to be more than a thousand. Thus, from this great number of quoted papers, from the personal experience of the author and from the general solidity of the work one may conclude that it is historically complete, for it is inconceivable that an author with such a profound knowledge of his sources could have overlooked any important fact. Indeed, one can rather be sure of the historical objectivity from the thoroughness and the style of this work.

If it be doubted that a younger physicist can make valid criticisms by means of the method of extrapolation, there are indeed three other features of such a work on which he can comment: the extent to which the book fulfils its purpose; the effort it demands from its reader; and one's reactions on reading the work.

Taking the first of these points, the number of facts considered in the 307 pages of text is astonishing. They are not superficially described, but form a carefully ordered and profound analysis of the development of theories. Many of the papers quoted are forgotten to-day; but the ideas do nevertheless form a part of present-day science, and it is impossible to understand the evolution of science without them. But Sir Edmund does not confine himself to enumerating the facts or describing them in simple words. He brings the reader to real understanding by a coherent mathematical description enabling him to follow the development step by step—though, indeed, only if the reader is willing to make a co-operative effort. Besides this, the book can also be used for reference purposes and as a collection of sources. Therefore it is essential for any library.

Turning now to the second point, the book is not written for the layman interested in the history of science, and certainly does not belong to the category of popular science books. The reader should possess a knowledge of differential and integral calculus, tensor calculus, matrices as required for Maxwell's theory of electricity, relativity and quantum theory. But it will suffice if one's knowledge of these topics is somewhat sketchy, because the author gives some assistance, as, for example, by a short introduction on tensor analysis and matrices. The contents of the book can be indicated by the following list of chapter headings: the age of Rutherford; the relativity theory of Poincaré and Lorentz; the beginning of quantum theory; spectroscopy in the older quantum theory; gravitation; radiation and atoms in the older quantum theory; magnetism and electromagnetism; the discovery of matrix mechanics; the discovery of wave mechanics.

How does the reader feel about this book—or rather, how did I feel? The clarity and the excellent didactic construction make it a pleasure to follow

Sir Edmund through the years 1900-26, though his book is sometimes not easy to read because of the condensed style and the fact that he often employs the nomenclature used in original work instead of that which would be used to-day. But this is surely an advantage and not a fault.

Besides the history of physics, one may learn from Sir Edmund one very important fact, namely, that it was of no advantage to have been living fifty years ago in order to make some of the great discoveries which to-day seem to be so easy and self-evident. From this book one can see that things were then much more complicated than they may now seem; in fact, they were just as difficult for physicists of that time as present problems are for us.

R. HAGEDORN

EVOLUTION OF THE HUMAN MIND

Anthropogenesis

A Study of the Origin of Man. By Prof. Ant. Pannekoek. Pp. 120. (Amsterdam: North-Holland Publishing Company, 1953.) 12s.

A THOROUGHGOING analysis of human origins would encompass the physical, the social and the psychological distinctions of *Homo sapiens*. It would indicate the phyletic stage and ecological setting in which hominid features first appear and attain their full expression. For much of what is essentially hominid begins to be recognizable all the way back in the Primate progression, and the transition from prehominid is never likely to be a sharp one. There are characters, too, which are closely interdependent, and a case could be made for their developmental, and perhaps genetic, correlation. Weidenreich, for example, has directed attention to the interacting changes characteristic of the transformation of the face and brain-case and the bending of the basiscranial axis. Already, palaeontology and comparative primatology, guided by the broad principles of animal evolution, offer enough to make the biological exploration of anthropogenesis a fascinating, if complicated, intellectual exercise.

Prof. A. Pannekoek's exploration scarcely touches on the biology of the matter. It is a long, sustained disputation of a hypothesis to account for the genesis of conceptual thinking, language and tool-making. The thesis is skilfully and forcefully argued and is worth following if the reader will bide his time in the opening discursive chapters and be prepared to go in and out of several neurological blind alleys. The theory is an amalgamation and re-ordering of a number of interrelated propositions which have been argued before. These are, briefly, that tool-making implies a developed capacity for conceptual thought (an idea elaborated by Elliot Smith), that speech and conceptual thinking develop reciprocally (as Darwin, ignored by the author, postulated) and, to complete the logical triad, that word-making is closely "akin to tool-making" (Charles Bell). Prof. Pannekoek examines and dissects each of these postulates in detail and finds them intrinsically convincing, though there is scarcely a material check which can be brought to bear on his premises or inferences. He urges the primacy of tool-making as the driving force in the development of the faculties

of human thinking and speech, though he emphasizes that, once started, all three activities would undergo a continuous mutual development. A point he labours is that "simple Darwinism" has led biologists to ignore the cultural factor of tool-making as the most potent agent of cerebral and mental development. But he himself quotes many writers who have accepted this possibility, though perhaps not to the extent of the author himself. There are places where the argument is not clearly developed. The enlargement of the brain is regarded in the main as a resultant of tool-making (p. 78), but some degree of enlargement is apparently a precondition in the earliest stages for cultural development (p. 107). Pannekoek criticizes, and with some justice, Elliot Smith's essentially orthogenetic view of brain expansion.

On Pannekoek's thesis, a protracted period of tool-using and of slow improvement in tool-making with concomitant lagging in brain development must have taken place (the palaeontological record supports this) with word use emerging relatively late. Interestingly enough, Prof. R. J. Pumphrey has recently¹ made a similar inference using less speculative arguments derived from the physical and physiological nature of language. Unlike Prof. Pannekoek, Prof. Pumphrey puts forward a piece of collateral evidence. He infers that the ability to use the "degenerate symbols" of language became increasingly manifest during the Upper Pleistocene; he suggests that this is mirrored in a pronounced tendency for the representational art of that period to exhibit progressive abbreviation and abstraction. The biggest omission in Prof. Pannekoek's discussion is the scant attention given to the emergence of the human social grouping in the development of the faculties of speech and thought.

J. S. WHINER

¹ Pumphrey, R. J., "The Origin of Language. An Inaugural Lecture." (Liverpool University Press, 1951.)

METHODS OF ORGANIC CHEMISTRY

Methoden der organischen Chemie

(Houben-Weyl.) Vierte, völlig neu gestaltete Auflage. Herausgegeben von Eugen Müller, unter besonderer Mitwirkung von O. Bayer, H. Meerwein und K. Ziegler. Band 8: Sauerstoffverbindungen 3, Peroxyde, Kohlensäurederivate, Nitrile und Isocyanide, Carbonsäuren, Decarboxylierung, Carbonsäureester, Funktionelle N-Derivate der Carboxylgruppe. Pp. xviii+776; 1952; 98 D. marks. Band 2: Analytische Methoden; pp. xxiii+1070; 1953; 139 D. marks. (Stuttgart: Georg Thieme Verlag.)

THE appearance of the first two volumes of a completely new edition of "Houben-Weyl" is a notable event in organic chemical circles. The third edition, of which Vol. 1 was issued in 1925 and Vol. 4 in 1941, enjoyed great popularity which is far from dissipated even now. In the fourth edition the subject-matter has been completely rearranged, and the articles in the two volumes now under review have been enlarged and modernized out of all recognition. The names of the contributors (for example, R. Criegee, H. Henecke, F. Arndt, B. Eistert, H. Roth, Th. Wieland) as well as of the editor and his associates are sufficient guarantee of the authenticity and quality of the work. Serial publications such as

"Organic Syntheses" and "Organic Reactions" and the series of Thailheimer, which have proved invaluable to the synthetic organic chemist, have in no way lessened the importance of "Houben-Weyl", which indeed gives extensive references to articles in the first two of these publications. A large proportion of all the references relates to original papers published after the third edition, and they include reference to many patent specifications and to FIAT reports and reviews.

Vol. 8, published in 1952, was the first volume of the new edition to be issued. It is said that the complete edition will consist of about fifteen volumes. Criegee contributes an article on peroxides, which gives an interesting survey of the several different types of preparative methods now available and contains a short section on the reactions and uses of peroxides. Derivatives of carbonic acid are dealt with by S. Petersen and H.-F. Piepenbrink in two comprehensive sections in which, for example, the reactions of cyanic acid, cyanogen halides, cyanamide, urea and guanidine are summarized in convenient tabular form. Various classes of dimeric and trimeric carbonic acid derivatives are described, and the part dealing with biguanide refers extensively to the publications of F. H. Curd and F. L. Rose and their collaborators in the researches leading to new antimalarial drugs. A long section on nitriles (by P. Kurtz) includes preparative details for anhydrous hydrocyanic acid, cyanogen and acrylonitrile, and contains also a few pages devoted to isocyanides.

The next section is concerned with the preparation, transformations and decarboxylation of carboxylic acids. This covers a whole range of interesting organic reactions. There are descriptions of methods for the direct introduction of the carboxyl group using carbon monoxide or carbon dioxide, of oxidation routes to carboxylic acids, of synthetic methods such as the acetosuccinic ester and malonic ester syntheses, the Perkin and Knoevenagel reactions, and of rearrangements such as the benzilic acid change, the Arndt-Eistert reaction and the Favorsky reaction. Decarboxylation comprises not only direct elimination but also rearrangements such as the Curtius and Schmidt degradations. Equally interesting and useful is the section on carboxylic esters, which gives examples of well-known condensation reactions. These include the Reformatsky reaction, the Darzens glycidic ester synthesis, Claisen's ester condensation, the Stobbe synthesis and the Michael reaction. These examples illustrate, incidentally, the use of the majority of the extensively used condensing agents; but the usefulness of the article would have been enhanced by including a discussion of their relative merits with an indication of the reagent of choice for specific types of reaction and molecular environment. The last section, dealing with nitrogenous derivatives of carboxylic acids, is followed by an author index containing all the names in the footnote references throughout the volume, and a subject index which is largely a list of names of compounds; page numbers of preparative methods are given in heavy type.

Vol. 2, issued in 1953, contains a most valuable comprehensive survey of the methods of analysis and the determination of physical constants of organic compounds. There is a detailed description of qualitative elementary analysis, and the quantitative section rightly gives most prominence to micro- and hemimicro-methods. The determination of oxygen is included among the methods of

elementary analysis, and also the estimation of silicon in organic silicon compounds and of metals in organo-metallic compounds. The 248-page section on elementary analysis concludes, appropriately enough, with a glimpse of the future in the shape of a brief survey of methods of 'ultramicroanalysis' by which, for example, combined carbon, hydrogen and oxygen estimations can be carried out with quantities of the order of 100-300 μgm .

Other analytical methods relate to the determination of specific molecular groups, to gas analysis (including adsorption methods and spectroscopic methods), thermal analysis of molecular compounds, chromatographic analysis and analysis of solvent mixtures. The chromatography section gives a detailed illustrated description of experimental methods, including paper chromatography and the use of ionic resins. In connexion with paper chromatography, it is curious that although the name of A. J. P. Martin appears in the literature references, no mention is made of R. L. M. Synge. Errors in transcription of names are easily made; one of the references in Vol. 2 gives A. C. Cook instead of A. H. Cook, and in Vol. 8 G. M. Bennett appears as G. M. D. Bennet. The section on gas analysis has a table of physical constants of upwards of forty gases, and this section is followed by a section on the determination of melting and freezing points, and of boiling and condensation temperatures. A valuable feature of this volume is the inclusion of a general bibliography at the end of most of the articles.

It is unnecessary to commend these two excellently produced volumes to organic chemists. They will be attracted to them instinctively.

J. W. COOK

MAGNETIC CHARACTERISTICS OF ROCKS

Rock-Magnetism

By Prof. Takeshi Nagata. Pp. viii+232. (Tokyo: Maruzen and Co., Ltd., 1953.) 5 dollars.

THE present interest in the interpretation of the natural residual magnetism of both igneous and sedimentary rocks makes this survey by Prof. T. Nagata of the characteristic magnetic properties of rocks most opportune. Of necessity, any interpretation of the observed natural magnetic polarization must be based upon a full appreciation of the magnetic behaviour of the rock constituents. The main geophysical problem is the cause of abnormal directions of magnetization, differing widely from that of the present earth's field, in many cases being in opposition to it. Two hypotheses have been advanced to account for this phenomenon: one requires large changes in the direction of the earth's field in the past, and the other seeks to explain the reversed polarization in terms of the intrinsic properties of the ferromagnetic constituents and their possible interaction under suitable physical conditions in a normal earth's field.

The opening chapter of the book is of a general nature and gives a brief review of modern ideas on magnetism, with special reference to ferromagnetic materials and the theories, advanced by Néel, of the behaviour of small ferromagnetic particles. It concludes with a review of the more common magnetic

minerals occurring in rocks. The next chapter is on the measurement of rock magnetism which, because of the small intensities of magnetization, requires special techniques. The usual magnetic properties—that is, hysteresis and the associated values of saturation intensity, coercivity and remanence, the effective susceptibility in weak fields, the variation of properties with temperature, Curie temperature, etc.—have one chapter devoted to them. In particular, the rock, regarded as an assemblage of mineral grains, and the relation between properties and concentration of minerals, are treated in some detail.

By far the most valuable, and longest, chapter is that devoted to the thermoremanent magnetism of igneous rocks, for it is this aspect which is of greatest significance in the interpretation of natural residual intensities. The author has made his most important contributions in this branch of the subject, and our knowledge of the details of the manner in which a rock acquires its large and stable intensity when cooled from above its Curie temperature is largely due to his work. The amazing behaviour of the dacite from Mt. Haruna which, when cooled in a weak field, acquires a polarization directed in opposition to the ambient field, is also discussed. Of the last two chapters, one is concerned with the magnetization of sedimentary rocks while the other considers some of the geophysical problems which arise from the general subject.

As a compilation of experimental data of the properties of rocks, mainly under laboratory conditions, this book is valuable; but the interpretation of the results is not always satisfactory or carried out in a sufficiently critical manner. As an example of this, a relation is deduced between the effective susceptibility of rocks in weak fields and their magnetite content. The observations show such a wide scatter that the value of the numerical interpretation is open to question and a significance test is essential for its full appraisal. Again, many of the conclusions are not generally accepted by other workers, particularly that on the mechanism by which the Mt. Haruna dacite acquires its adverse polarization. The book is well printed and generously illustrated. One major fault—for which Prof. Nagata is not responsible—is the English, which leaves much to be desired.

J. M. BRUCKSHAW

WEATHER NEAR THE GROUND

Micrometeorology

A Study of Physical Processes in the Lowest Layers of the Earth's Atmosphere. By Prof. O. G. Sutton. Pp. xii+333. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 61s.

DR. SUTTON has written the book that only he could write; and there will be a warm welcome for this illuminating survey of territory that he himself has done so much to extend. A flipper reviewer will perhaps be forgiven for suggesting that the sub-title ought to be "Mathematical Processes in the Lower Atmosphere", for this is a mathematician's book with the scope and content of which there could be little quarrel were the design limited to producing a survey of postgraduate standard for mathematicians and physicists. The author, however, specifically states that he has attempted to meet the needs of workers in other fields who require detailed information about physical processes in the regions

of the atmosphere where life is most abundant. To these other workers—biologists and the like who make up the great bulk of practising micro-meteorologists in the world—the book will be difficult where it is relevant, and disappointing where it is silent on what they regard as the important problems of micro-meteorology: air movement, temperature and humidity gradients inside crops and forests; the physical environment of insects and animals; the dispersal of atmospheric plankton with non-negligible terminal velocities of fall; and wind erosion, to name only a few. At present, of course, the meteorologist can do no more than provide a qualitative discussion of the physics of some of these problems; but a lead from Dr. Sutton would have been invaluable in stimulating thought and experiment.

The first of the eight chapters clears the way for later arguments in describing the static properties of the atmosphere. The next two deal with air moving in laminar flow and turbulent flow, the former primarily to set out and explain the basic aerodynamic equations and to introduce the concepts of shearing stress, viscosity and mean free path. Against this background there is an extended survey of mixing length theories in turbulent flow, first on the molecular analogy of Prandtl and then on the statistical basis initiated by Taylor. The analysis at this stage is mainly used to derive velocity profiles over smooth and rough surfaces, and the corresponding momentum transport constants. Here, as elsewhere, the mathematics is crisply set out and the argument uninterrupted: but at the expense of a discontinuity it would be helpful to have some discussion of the physical implications of these differing concepts of mixing length.

After considering the transport of heat in free convection, diffusive processes are studied in general terms that permit the analysis to be applied not only to heat transfer but also to imponderables in the atmosphere—water vapour, smoke and other pollution with negligible terminal velocities of fall.

The chapter on radiation is pure meteorology and includes an extended treatment of long-wave radiation leading to a discussion of the possibilities of predicting night minimum temperatures. As 'micro' meteorology this chapter might well have included some discussion of radiation exchanges between small bodies and their environments, a topic of wide importance in most branches of outdoor biophysics, particularly in the measurement of temperature. Almost every temperature measurement involves an uneasy compromise between adequate shielding from radiation and adequate exposure of the element to the environment. A section on the micro-meteorology of meteorological instruments would be a very welcome addition to a future edition of the book.

The remaining three chapters of the book take the mathematical analysis of the first part into the field to match formulae against facts. Temperature distribution and heat flow are considered after a preliminary survey of the heat balance at the earth/air boundary; from temperature, on to wind, with details of wind profiles over rough surfaces and the influence of atmospheric stability on them. Read in conjunction with his earlier chapter on turbulent flow, this chapter justifies Dr. Sutton's statement that there has been much energy spent and ingenuity exercised in investigating problems of wind structure. Has it been overdone? The author's reply would doubtless be to ask the questioner to re-read his final chapter to find there how all that has gone before

can be used in solving problems of dispersal of smoke and other forms of atmospheric pollution, and in providing complete, if complex, expressions for evaporation-rates from open water. These expressions would have much greater practical value if they were accompanied by short tables giving a range of values of the stability-dependant constants that appear in equations 8.55, 8.56 and elsewhere: not everyone who will want to use this chapter will possess tables of incomplete gamma functions or know where to find them.

For a summary impression of the book as a whole we can go back to its beginning. It is dedicated to Sir David Brunt: it is a worthy offering.

H. L. PENMAN

SELECTIONS FROM THE WORKS OF C. G. JUNG

Psychological Reflections

An Anthology of the Writings of C. G. Jung. Selected and edited by Jolande Jacobi. Pp. xxvii+342. (London: Routledge and Kegan Paul, Ltd., 1953.) 30s. net.

THIS anthology of Jung's writings, compiled by Dr. J. Jacobi, is a bedside book: "The object is to show by means of a cross-section a few of the more important aspects of existence reflected in humanity in general, when understood and illuminated by Jung's Psychology. It was not the intention to present Jung's theory; therefore everything which is technical has been excluded".

The publishers recommend this book "not only for the use of scientists, but for all who want to arrive at a better knowledge of themselves and the world". They are presupposing that there is a discovery to be made which is not only scientific discovery—discovery by observation and deduction therefrom in strict accordance with logical rules—but also a discovery by reflexion, a moral discovery.

The whole work of Jung as a man of science poses the question of validation. If the basis of science turns out to be 'unscientific' and 'facts' are as indeterminate as any symbolical experience, then we have to admit that Prof. C. A. Coulson is right when he states that facts say nothing at all; what matters about truth is not the facts, but the interpretation of the facts.

Just as, in physical science, concepts like atoms and electrons are logically unobservable but are validated by analogy, so it is with the working of the mind. What are being experienced there are not fixed things but reflexions of experiences which manifest themselves in symbolical terms. Man to-day, however, is conditioned by his 'scientific' training to think quantitatively and forgets that validation is experienced also in image thinking. Verbal thinking and image thinking go side by side, and Prof. H. H. Price says in his book, "Thinking and Experience" (p. 252): "If rainbows, reflections, mirages and the like had been less common than they are, philosophers would have denied their existence on *a priori* grounds. For how can there be entities which are at once physical and non-physical, in the physical world and yet not of it, existing from some points of view and not from others, spatial but lacking backs or insides? The fate of mental images, in these latter Verbalistic days, has been somewhat

similar. We have the misfortune to live in the most word-ridden civilization in history where thousands and tens of thousands spend their entire working lives in nothing but the manipulation of words. The whole of our higher education is directed to the encouragement of verbal thinking. Let us hope that our successors will be wiser, and will encourage both".

It is with image thinking that Jung's work is concerned. Those who are not too much bogged down in verbal logic, and thus able to experience that there is active also a process of imaging in man's faculties of cognition, will be able to appreciate the significance of this book. The anthology is a useful introduction to the rest of Jung's work. It shows clearly the fundamental weakness of Jung's psychology, which by having no fixed scheme appears to be full of contradictions and paradoxes; but this weakness is at the same time a sign of its greatness. For, life in the psyche manifests itself thus: "You cannot step twice into the same river, because fresh waters are ever flowing in upon you". H. WESTMANN

THE PROGRESS OF PLANT PHYSIOLOGY

Annual Review of Plant Physiology

Vol. 4. Daniel I. Arnon (Editor). Leonard Machlis (Associate Editor). Pp. x+453. (Stanford, Calif.: Annual Reviews Inc., 1953.) 6 dollars.

NOTHING could emphasize more strikingly the rapidity of the growth in knowledge of the physiology of plants than the "Annual Reviews of Plant Physiology" published under the general editorship of Dr. D. I. Arnon and Dr. L. Machlis. No longer can the plant physiologist, by the reading of original papers only, hope to keep up to date with all the aspects of his subject, and all students and teachers of plant physiology should feel grateful to the editors, contributors and publishers of these reviews for making it possible for the generality of plant physiologists to obtain a reasonable appreciation of the work done in those branches of the subject outside their own specialist interests. Each annual volume, four of which have appeared at the time of writing, does not attempt to cover the whole field of plant physiology, but contains a number of reviews, fifteen in each of Volumes 3 and 4, written by authorities in their respective fields, of a limited number of particular aspects of the science, those which are undergoing rapid development being dealt with more frequently than those which are attracting less attention as current subjects of research. Thus, photosynthesis was dealt with in 1952 by E. Rabinowitch, while in the 1953 volume it is reviewed by A. H. Brown and A. W. Frankel and reviews on certain aspects of photosynthesis by D. Burk and L. R. Blinks are promised for 1954. On the other hand, a number of topics such as the physiology of root growth, the biogenesis of terpenes, the plant sterols and fluorescent substances in plants by H. Burström, A. J. Haagen-Smit, W. Bergmann and R. H. Goodwin respectively are reviewed in the 1953 volume but are not in the list of subjects for 1952 or 1954. This policy would appear to be a wise one, for it has the result that each branch of the subject considered contains enough material for an article of reasonable length the writing and reading of which are worth while.

Among articles in the 1953 volume dealing with plant metabolism, apart from those already mentioned, is one by J. G. Wood on the nitrogen metabolism of higher plants in which recent work on the path of nitrate reduction and protein synthesis in plants is adequately summarized. Another aspect of plant metabolism attracting much interest at the present time, namely, the part played by organic acids in metabolism, is ably reviewed by R. H. Burris, while the important question of the use of respiratory inhibitors is exhaustively dealt with by W. O. James, who refers to no less than 247 contributions bearing on this subject. A valuable review on haematin compounds in plants is the work of R. Hill and E. F. Hartree. This includes an account of the distribution of haematin compounds in plants with some remarks on the possible part played by these substances in photosynthesis, a discussion on the cytochrome system as a terminal oxidase in plant respiration, the role of this same system in salt respiration, the function of haemoglobin in the root nodules of the Leguminosae, and an account of recent work on catalase and peroxidase.

Reviews concerned with the popular topics of growth substances and herbicides are contributed by H. Veldstra and A. S. Crafts respectively, while the physiology of fruit growth, a subject about which not a great deal is known, is dealt with in a stimulating review by J. P. Nitech.

The remaining reviews which make up the 1953 volume are on the physiology of mycorrhizal relations in plants by E. Melin, the effect of temperature on plant growth by F. W. Went and the physical properties of protoplasm by H. I. Virgin.

The enormous amount of literature reviewed in a single volume and the high standard maintained generally by the various contributors make these annual reviews a most valuable addition to the literature of plant physiology. They are, indeed, a necessity to the plant physiologist who means to keep abreast of advance in knowledge of his subject.

W. STILES

RECENT ADVANCES IN SPELEOLOGY

British Caving

An Introduction to Speleology. Edited by O. H. D. Cullingford. Pp. xvi+468+48 plates. (London: Routledge and Kegan Paul, Ltd., 1953.) 35s. net.

THE publication of this book marks a conspicuous advance in the study of British caves and shows that modern cave exploration must be regarded as something more than a 'sport'. Hitherto, much material of scientific value about limestone caves has remained either unpublished or hidden away in the little-known journals of local caving clubs. The collection of this scattered information, together with an introduction to the many problems with which caving is concerned, has now been attempted by fifteen members of the Cave Research Group. This Group was formed in 1947 to further "the study of all scientific aspects of cave exploration"; "British Caving" is the Group's first major publication, and is also the first book to cover comprehensively the chief aspects of British caves and caving. Its aim is twofold; first, to give an account of the recent work on caves and the advances in caving techniques;

secondly, to provide, for the rapidly growing numbers of cave explorers, with little or no scientific training, both a guide to the organization of caving and to scientific methods of observation.

The book is divided into two parts. Part I is the larger and is called the "Science of Caving". In this part, Dr. Warwick summarizes the many problems connected with the origin of limestone caves and with the relationship of the caves to the surface land-forms; he also contributes a chapter on the main characteristics of the caving regions of the British Isles. Dr. Wilfred Jackson's contribution is a detailed account of the British caves from which archaeological remains have been obtained; its value is mainly bibliographical and the chapter contains an extremely useful list of the museums where the various 'cave finds' can now be examined. Miss Hazelton and A. E. Glennie have written a section on how to observe and to collect cave fauna and flora; a comprehensive list of the fauna and flora so far recorded from caves in the British Isles is also included. A fascinating chapter, illustrated by a series of fine photographs taken by J. D. H. Hooper, describes the studies now being made in south Devon on cave-dwelling bats. Chapter 7 briefly mentions certain physical aspects, such as air currents and temperatures, the tracing of water-flow under ground and geophysical methods of locating caves. Finally, there is a chapter on the caves associated with lead mines; this is, however, rather slight and is in many ways not up to the general scientific standard of this part of the book.

Part 2 deals with the "Practice of Caving". There is a short note on the history of cave exploration and this is followed by discussions of the equipment and of the procedure and safety precautions necessary in any cave investigation. The chapter, by F. G. Balcombe, on the history and work of the Cave Diving Group is one of the most exciting stories to be told in modern caving. Part 2 also contains clearly written instructions and suggestions on cave photography and on cave surveying. An appendix gives a list of the caving organizations in the British Isles and a glossary of some of the terms used in connexion with caves and limestone areas.

The book is very readable, though as might be expected in a compilation there is considerable unevenness in the treatment of the different topics, and occasionally an incongruous mixture of styles. Moreover, the book covers a field so wide that unavoidably many geological and other problems have to be over-simplified. Full bibliographies at the end of each chapter partly overcomes this defect. Many of these bibliographies would be of greater use if they were more selective; since, also, the literature about caves is of very varying quality, annotation would help the beginner both to acquire the basic scientific knowledge and to discriminate between the useful and less useful references. The reviewer also regrets the substitution of the American words *cadose* (above the water-table) and *phreatic* (below the water-table) for the English terms long in use by British geologists.

"British Caving" is well printed and produced and contains about eighty photographs and many clearly drawn maps and diagrams. The book is indeed a tribute to the amount of solid work put in by the Group; it should introduce many, as its writers hope, to the wonders of limestone caverns, but what is probably more important is that it should establish speleology as a well-defined branch of modern natural history.

M. M. SWEETING

THE EXPERIMENTAL STUDY OF SPEECH*

By DR. D. B. FRY

Department of Phonetics, University College, London

THE speech process consists of a series of transformations, from the stage of the linguistic memory through nervous and muscular activity to that of variations of air pressure and then back again. The purpose of the experimental investigation of speech can be summarized as the study of these transformations, the establishing of correlations between events at each succeeding stage, and the examining of the form of these correlations.

In recent years, the study of speech has been influenced by new points of view and by the development of new experimental methods for exploring the correlations between the linguistic, the physiological and the physical aspects of speech. Experimental research by its very nature imposes an operational view of the subject-matter to be examined, and the adoption of such a view of speech might at first appear to preclude work on certain of the linguistic aspects of speech such as 'meaning'. It is quite possible, however, to explore experimentally the associations of words and other linguistic units for different individuals. Lenneberg¹ has done some research, for example, on the associations of words for colours. He presented a number of subjects with a great variety of different colours, varying the hue and the brightness in a systematic way, and then correlated the words used by the subjects to denote the colours with the variation in the stimulus. In these experiments there is a very obvious physiological component; subjects who have some degree or type of colour blindness are likely to have fewer associations in common with the rest of the population, though they may show a good deal of agreement among themselves. The results in general showed that the degree of agreement between individuals varied as the stimulus was changed: there were a number of points of maximum agreement, at some of which the subjects were unanimous in their choice of a word—thus for some particular colour everyone used the word 'red'; then as the stimulus was changed in a given direction, gradually a greater diversity of words was used. In addition to this general pattern of agreement, it was possible to see fairly systematic variations of association according to the background of the individuals.

What is usually referred to as the meaning of a term is therefore from this point of view the total of the associations held in common by the majority of the users of the term. Experimental work based on this point of view is naturally most easily carried out on the associations of concrete words. Although the extent of the linguistic material that can be explored in this way is obviously limited, the results do shed some light on the way in which this part of the speech process works, and by the use of such methods the semantic factor in speech can be brought within the range of experimental work.

Another important feature of the linguistic aspect is the influence of context. At the phonemic level, the effect of context is generally viewed nowadays in terms of communication theory. Shannon's con-

clusions about the statistical structure of written English² are applicable to the sound system of a language. The experiment in which he asked a subject to guess the sequence of letters in an English sentence can be repeated with the sounds of spoken English, provided the subject has had enough phonetic training to think in terms of sounds rather than letters. The technique is to choose a sequence of English sounds forming a sentence and then to ask the subject to guess each successive sound. The number of guesses required to arrive at the correct sound shows considerable variation. At the first position the number is high, and it shows in general a gradual decrease as the sequence proceeds; within this general trend, there are smaller rises and falls at succeeding points in the sequence, the peaks of uncertainty usually falling at or near word or syllable junctions. These results have encouraged several workers to explore the usefulness of distributional criteria as a basis for defining linguistic units³.

In investigating the function of the nerve connections in speech, a valuable step forward has resulted from the study of feed-back mechanisms and the part that they play in the speech process. The methods used depend in every case on some interference with the feed-back—interference which may be temporary and artificial, or the result of a pathological condition and more or less permanent. For example, the case of the congenitally deaf child is more clearly understood, since the enormous importance of the auditory feed-back for speech has been appreciated. The training of such children is seen to require first and foremost the provision of any degree of auditory feed-back that is possible for the particular child, and then the supplementing of this by the use of visual, tactile and kinaesthetic feed-back.

The methods of interfering artificially with the feed-back circuits have been concerned with the auditory feed-back, and have consisted in either obliterating the feed-back altogether, or in delaying it. This interference is possible because, when we sing or speak, most of the sound which we ourselves hear is conveyed to our ears by bone conduction. The bone-conducted sound can be completely masked by supplying to the ear some other sound of sufficient intensity by air conduction; the latter may be a very loud masking noise, which obliterates the auditory feed-back altogether, or it may be the subject's own speech (or singing) delayed by some time interval. One of the effects of obliterating the feed-back altogether, for example, is that the mechanism which controls the pitch of the singing voice no longer functions properly and the subject can no longer sing in tune. When the feed-back is delayed, the effect upon speech is very dramatic. It appears that the speech mechanism is very sensitive to delay in the auditory feed-back, at least over a certain range of delay times. The effect produced varies with individuals and with the delay time; but it generally takes the form of an artificial stammer, and the speaker in this condition feels himself under considerable nervous stress.

* Substance of a lecture delivered in University College, London, on March 16.

Experimental evidence about the functioning of muscular systems has been obtained in recent years largely by means of photographic methods. The change from muscular movements to wave motions in air is one which we should expect to yield a close correlation between the two sets of events, and for this reason many attempts have been made to obtain a more exact record of these movements both at the level of the larynx, which may be regarded as the primary generator of the wave trains of speech, and also at the level of the articulatory mechanism which modifies the output of the larynx. High-speed direct photography has been applied to the study of the functioning of the larynx at the Bell Telephone Laboratories, where for the first time some of the modes of vibration of the vocal cords have been recorded; this work has provided evidence of the relative times of the open and closed phase of the cords, which are seen to vary with individual speakers and with the fundamental frequency of the vibration. This matter is of considerable importance to any attempt to calculate the physical output of the speech mechanism from a consideration of its physiological and anatomical properties. Still further evidence about laryngeal functioning has resulted from the improved X-ray photographic techniques which are now available. The internal action of the larynx was for a long time inaccessible to X-ray photography, but the development of the tomogram technique has enabled Ardran and Kemp⁴ to obtain remarkable records of the larynx in action. The evidence which they offer concerning the sphincteric action of the larynx may well lead to a reconsideration of the way in which this part of the speech mechanism functions.

Photographic methods, both direct and X-ray, have been applied also to the examination of the articulatory mechanism. Films have been taken of subjects in whom some abnormal anatomical condition allows a direct view of parts of the speech mechanism. The first of these, made in 1943⁵, showed the movements of the tongue in the speech of an English subject whose right cheek had been removed surgically. In a more recent film of a similar nature, it is possible to see from above the changes in the disposition of the soft palate during speech. All such records are open to objection on the grounds of the abnormality of the subject, both from the point of view of anatomy and of the acoustic output of his speech mechanism. On the other hand, there is a strong argument for attributing some degree of normality to the movements which we see, since we know that it is very difficult for the adult human being to change his speech movements, a fact which is brought home afresh to anyone who tries to learn to speak a new foreign language.

The physical aspect of speech is much more accessible to experimental study than the linguistic and physiological aspects, and it is possible to give a very full description in physical terms of the wave motions of speech. The difficulty consists in establishing the correlations between features of the wave-motions and the perception and understanding of speech by the listener. The classic view of the problem was that speech sounds consisted, physically, of a more or less rapidly changing complex of frequencies, among which a few high-amplitude components, called the 'formants', were responsible for the discrimination of different sounds by the listener. Hence the most favoured method of examining the speech wave-motions was by a process of frequency

analysis which would lead to the detection of the formants. A system which is particularly adapted to this purpose is the one which was at first labelled 'visible speech'. This was developed by the Bell Telephone Laboratories⁶ during the war years and is essentially a conventional system of frequency analysis; its new feature is the provision for presenting the analysis extended along the time axis. The output of the system generally takes the form of visual patterns, known as 'spectrograms', in which time is represented on the horizontal axis, frequency on the vertical axis, and the relative intensity of the frequency components is indicated by the gradation from black to white in the pattern.

Many people have, in recent years, come to the conclusion that frequency analysis, in its classical form, is not the real basis for recognition, and have sought to develop other methods of inspecting the speech wave-motions. It has been suggested, for example, that the discrimination of sounds might depend on the perception of differences in the frequency with which the wave-form crosses the zero line, and that all speech sounds might be recognized on this basis. It is possible by electronic circuits to transform the speech waves in such a way that each zero-crossing is represented simply by a pulse, and these pulses can be counted electronically in order to arrive at the frequency of zero-crossings for given unit times. The first important result obtained by this method⁷ was the demonstration that if the pulses themselves were simply transformed into acoustic wave-motions, they constituted sounds which were perfectly intelligible as speech to the ordinary listener, thus showing yet again that speech is extremely resistant to a great variety of distortions. In addition to this, many experiments have been made in which the zero-crossings have been, so to speak, re-arranged: they have been averaged over various time-intervals; they have been spread out and condensed along the time axis; the negative-going pulses have been omitted altogether and have also been replaced by positive-going pulses with very interesting results; the form of the variation in zero-crossing frequency for different speech sounds has been closely examined. The results of many of these experiments have not yet been published; but up to the present there appears to be no very strong evidence that any method of treating the zero-crossings yields results showing an appreciably closer correlation with the linguistic units than the results of more conventional systems of frequency analysis.

All these ways of inspecting the speech wave-motions aim at discovering the perceptual-physical correlations by transforming the wave-motions in a variety of ways in the hope of finding one method which will give the desired correlations. An alternative to this method is the use of a speech synthesizer, a machine which will generate speech-like sounds of a relatively simple physical nature and by means of which the effect of single physical clues to the primary recognition of sounds may be explored. A number of such synthesizers are now in use and many interesting results have already been published. Liberman, Delattre and Cooper⁸, using a synthesizer which produces sounds from simplified spectrograms, have shown that a short burst of sound lasting about 15 msec. and covering a narrow frequency-band will be recognized as a consonant of the plosive type when it is combined with a vowel-like sound. In one series of experiments, the location of this burst on the frequency-scale was taken as the

single physical clue, and it was found that listeners judged the consonant to be *p*, *t* or *k*, depending on the position of the burst and on the vowel with which it was combined. A second series of experiments was concerned with another clue which appears to be important for the primary recognition of consonants¹. This is the 'formant transition'—the way in which the frequency of a formant changes in the course of a syllable. Synthesized sounds consisting of two formants the frequency of which remained constant throughout were recognized by listeners as single vowels; if, however, the formant frequency was changed fairly rapidly during the first 50 msec., the listener heard the vowel preceded by a voiced plosive consonant. The direction of the frequency-change, its extent and the particular vowel sound concerned, all combined to determine whether this consonant was *b*, *d* or *g*.

In further experiments with the same synthesizer, Denes¹² demonstrated the importance of time-relations for the primary recognition of speech sounds. Listeners judged a fricative sound to be either *s* or *z* according to the ratio of its duration to that of a preceding vowel. When the fricative was short compared with the vowel, the majority of subjects heard *s*; and these judgments changed in favour of *z* as the friction was made progressively longer compared with the vowel.

Time relations were again shown to be an effective clue for recognition by work which I have carried out¹³. The object of these experiments was to test the effect of the ratio of durations and of intensities as clues for discriminating between stressed and unstressed syllables in English. The material used for this study was a group of words like 'object' in which, for most speakers, a change of function from noun to verb is accompanied by a shift of the stress from the first to the second syllable. Many different versions of each word were synthesized in which the ratios of durations and of intensities of the two vowels were varied over a considerable range. Listeners were then asked to say whether they recognized the noun or the verb form in each case. The results of this test showed that both duration and intensity operated as clues for recognition, but that the duration clue was much the more effective. The whole range of intensity-changes was responsible for a change of only 27 per cent in listeners' judgments, whereas the range of duration changes produced a change of 71 per cent.

This experimental procedure, which makes it possible to examine the operation of physical clues separately, has already done a great deal to make clearer the general nature of the recognition process, and to suggest the terms in which it may be possible in the future to state the very complex correlations that exist between the perceptual and the physical in speech.

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² Shannon, C. E., *Bell System Tech. J.*, **37**, 879 and 923 (1948).

³ O'Connor, J. D., and Trim, J. L. M., *Word*, **9**, 103 (1953).

⁴ Ardian, G. M., Kemp, F. H., and Mandin, L., *Brit. J. Radiol.*, **36**, 497 (1953).

⁵ Bogue, J. Y., and Fry, D., *Endeavour*, **2**, 11 (1944).

⁶ Potter, B. K., Steinberg, J. C., et al., *J. Acous. Soc. Amer.*, **18**, 1 (1946).

⁷ Licklider, J. C. R., and Pollack, I., *J. Acous. Soc. Amer.*, **20**, 43 (1948).

⁸ Liberman, A. M., Delattre, P., and Cooper, F. S., *Amer. J. Psychol.*, **65**, 497 (1952).

⁹ Delattre, P., Cooper, F. S., et al., *J. Acous. Soc. Amer.*, **36**, 137 (1954).

¹² Denes, P., paper read at the meeting of the Acoustical Society of America, October 1953.

¹³ Fry, D. B., *J. Acous. Soc. Amer.*, **36**, 138 (1954).

GOETHE'S SCIENTIFIC BACKGROUND

IT has been said that, whereas we know next to nothing about Shakespeare's life, almost too much is known about Goethe's. His autobiography, diaries, correspondence, carefully recorded talks, and innumerable scattered notes which were never meant for publication, provide such an inexhaustible wealth of material that any exegete intent on emphasizing a special tendency in Goethe's mind could produce some evidence for his thesis if he is willing to spend enough time on the perusal of every available source.

A recent book by Dr. Ronald D. Gray on "Goethe the Alchemist"^{*} sets out to show "that Goethe was profoundly influenced throughout his life by the religious and philosophical beliefs he derived from his early study of Alchemy". It is a very learned book, so rich in not easily accessible material that admirers of Goethe will study it with pleasure and profit, even though they may be unable to agree with the author's opinion.

Goethe's interest in alchemy is well known to every reader of "Faust"; it may even be correct to say that all that the average educated German knows about alchemical imagery is contained in the few very colourful and impressive lines in which Faust describes the laboratory experiments of his deceased father. From the second part of "Faust", many will remember also the alchemical origin of Homunculus. It is certainly a merit of the author to have searched with enormous industry for further alchemical ideas and symbols not only in Goethe's lesser-known poetical works but also in his scientific writings, and much of what he has to say about alchemical reminiscences in Goethe's "Farbenlehre", his "Metamorphose der Pflanzen", and his anatomical, geological and meteorological papers, will strike the reader as worth pondering about; but it is usually far from convincing.

A great deal has been written about Goethe's strange theory of the origin of coloured light and his stubborn refusal to listen to any German defender of Newton's explanation. To Goethe, his theory of colours was much more than the solution of an isolated problem in physics; it was, as has been shown by many writers, intimately connected with his personal way of searching for explanations of natural phenomena; but whether we can see in his colour-theory as close a connexion with alchemy as Dr. Gray suggests is quite a different question. He wants to make us believe that the empirical appearance of Goethe's colour-theory is only "superficial" and that, first of all, it had to conform with alchemical doctrine, with the colour changes described by alchemists as essential for their 'Great Work'. Considering the small number of the six or seven rainbow colours mentioned in alchemical writings, occasional similarities with Goethe's statements will not surprise us—all the less, since the alchemists, like Goethe, were starting from actual observations, and many of them were by no means so completely lost in symbolism as readers of some recent books, for example, those by C. G. Jung, may believe. The influence on Dr. Gray of Jung's re-interpretation of alchemy is very obvious, and he goes even further in the same direction in his attempt to show that in Goethe's

^{*} Goethe the Alchemist: A Study of Alchemical Symbolism in Goethe's Literary and Scientific Works. By Ronald D. Gray. Pp. x+312+3 plates. (Cambridge: At the University Press, 1953.) 35s. net.

theory of colours, too, not the experimental content but the symbolism is essential; but it is almost inconceivable that anyone could get such an impression who studies Goethe's work without a preconceived idea. With infinite patience experiment after experiment was described by Goethe, and the reader exhorted to repeat and check them; this has been done by many who have realized with admiration that Goethe, whose colour sense must have been of a very high order, was not only extremely accurate in his descriptions but was also sometimes even the first to notice some delicate phenomenon. To the countless experiments and historical studies connected with his theory of colours, Goethe devoted probably more effort than to any other single work.

Goethe himself was very careful to draw a clear line between the scientific part of his theory, which he was confident could by experiments be demonstrated to be superior to Newton's, and the entirely different concluding section on "the sensorial and moral effect of colour" ("Sinnlich-seitliche Wirkung der Farbe"). This subject is naturally quite different; here Goethe the artist is speaking, and it is very unfortunate that without warning to his readers Dr. Gray mixes the quotations from both parts. Right at the end of this last section, one or two pages are devoted to the "Allegorical, symbolical and mystical use of colours". Here Goethe declares that he did not want to be suspected of mysticism ("Schwärmerei") and predicts that, according to the fashion of his days, there would anyhow be no lack of allegorical, symbolical and mystical applications of his theory. This remark is no encouragement for such attempts, and Goethe did not foresee that he might have to fear even an alchemical interpretation, such as presented now in Dr. Gray's book. As "final evidence" for his thesis, Dr. Gray quotes a passage in which an old anonymous writer says that his remarks about colours "can be combined with the secret philosophy and experience of the chemists", a passage republished by Goethe in one of his occasional minor writings; we are told that this is "the frankest declaration on Goethe's part of the fact that his Colour-Theory was only to be fully understood in terms of alchemical symbolism". If that is the frankest, our doubts are scarcely dispelled as to whether the author is on the right track, or whether he is perhaps deluding himself when he believes he notices everywhere in Goethe's theory of colours the smell of alchemy.

Discussing the meteorological images in Goethe's poetry, Dr. Gray quotes a passage from the final scene of "Faust II" where clouds change into a host of blessed spirits. "The immediate source of this image can be traced back to a moment of Goethe's life some fifty years before those lines were written"—so we are told, and a remark is quoted from a letter written in the far-distant days when alchemy was still near to Goethe's heart. Now for the modern author, who has all Goethe's works simultaneously available, this source may appear "immediate"; but for Goethe himself a letter written to a friend fifty years earlier can scarcely have been an immediate source, nor is it likely that just one, not at all unusual, observation of so long ago was still present in his memory.

It is not to be expected either that the alchemical explanation of the *Urpflanze*, to which Dr. Gray devotes much space, will convey conviction to many. We are informed that the stages of this hypothetical plant correspond to Boehme's "Seven Qualities of

God", and in some of the stages no doubt resemblance can be found; but it is only "by ignoring Goethe's definite statement that there are six stages in the life of the plant, and including what he omitted, the original seed" that it was possible for the author to establish "a very close parallel with mystical doctrines". Here again we meet the usual trouble: Goethe was careful "to publish only the barest hints. The passages which most reveal his thoughts are found almost entirely in his private notes or in later publications".

It must be conceded to Dr. Gray that, although it was his professed task to go so far as possible in an attempt to follow up in Goethe's works alchemical influences, he nevertheless sometimes shows restraint, when we are already fearing the worst. We are certainly grateful to him that, after drawing "Iphigenie" into a chapter on Amazons, hermaphrodites and the symbolism of the "male and female" in alchemical writings, he assures us that in spite of "the union of opposites, sun and moon, brother and sister", which provides a happy conclusion of the play, "it would be absurd to claim Iphigenie as an example of Goethe's use of alchemical symbolism". Mignon is not so fortunate; she is plainly called a hermaphrodite, although Dr. Gray admits that she is not quite so perfect a being as this—in alchemical parlance—very laudatory expression indicates. On the other hand, one feels again relieved when the sentence "it would make for a neat interpretative pattern if one could agree with C. G. Jung that the whole of Faust II is a poetic representation of the alchemical work", is followed by a "but"; one would wish, however, that here the author's objection was not confined to the lack of alchemical symbolism in the third act of "Faust II", but that he would say in so many words how pointless the whole "Faust II" would appear to most of us if Goethe's ambition had really been what Jung supposes; we should be inclined to say, in Mephisto's words, "ein grosser Aufwand, schmachlich, ist vertan".

Dr. Gray is so convinced that the expressions Goethe uses in the description of natural phenomena must come from the writings of the alchemists, that he assumes such a parallel even if he has no proof at all to offer. Goethe believed that the crystallization of rocks was accompanied by a tremor; the author admits that here the parallels with alchemical literature "are not as close as one could wish", but he "feels" that some of the alchemists "also must have used such expressions" for their process, although he has "not chanced to come across any such passages". Why should we look for such a distant and purely hypothetical source of Goethe's views if (in a paragraph quoted in the present book) he refers to the simple observation that "water in a vessel, on the point of freezing, is transformed by the slightest shock into solid ice"? Let us not forget that if Goethe was anything in science, he was a brilliant observer. For a similar reason, there can be no necessity at all for assuming that, when Goethe likened little clouds to white doves, these birds must have been reminiscences of alchemical symbols he had come across in his youth, and that only "later he came to feel that Nature herself offered such symbols in plenty". After all, he was a poet too.

It is to be hoped that no reader of this book will forget that its aim is to bring out certain aspects of Goethe's *Weltanschauung* by sharply illuminating them from a certain angle, and that by this process other features are necessarily obscured. The study

of "Goethe the Alchemist" should be followed by the reading of books with titles like "Goethe the Classicist", "Goethe the Spinozist" and, most necessarily, "Goethe the Scientist". The author himself is helpful here in providing a list of "Books and Articles consulted", which comprises, in the section entitled "Goethe's Science", some fifty authors. Three very valuable contributions to the subject are, however, missing: Helmholtz's and Tyndall's well-known studies on Goethe's scientific work and—less astonishing, but still more regrettable—O. G. Carus's little book "Goethe" (Leipzig, 1843). For anyone who has ploughed his way through the complicated symbolism attributed to Goethe in Dr. Gray's book, it will be most refreshing and clarifying to read Carus's chapter on "Goethe's Relation to Nature and Science". Discussing his various contributions to science, Carus gives pride of place to the idea of the *Urpflanze* which had been "of the highest and most enlivening effect on the whole field of botany". (Similar praise is bestowed on his anatomical ideas.) Is it likely that a revival of Boehme's and other alchemists' and mystics' abstruse ideas, "a cunning and intricate pattern of metaphor and simile, elaborated down to the smallest detail"—as Dr. Gray calls Goethe's botanical theory—could have had such a beneficial influence on the progress of modern science? I believe it to be very significant that neither in this chapter, nor in the one which attempts to explain Goethe's works "from an understanding of his personality", are alchemical interests mentioned by Carus even once. He must be considered as one of the most competent judges, as he knew Goethe personally, enjoyed his affection and respect as shown in their correspondence and had many scientific and artistic interests in common with Goethe, being himself eminent in such various fields as anatomy, psychology, philosophy and painting. If Carus, in his explanation of Goethe's scientific background, could leave out alchemy completely, one's suspicion is strengthened that Dr. Gray's point of view is only the purely literary and utterly non-scientific attitude of a late interpreter, and that it is the arbitrary emphasis which he lays on a few of the remotest of Goethe's utterances that makes the alchemical influence appear of such over-riding importance.

We are nevertheless indebted to Dr. Gray for having spent so great an effort on the pursuit of this single line of research, and for having collected the scattered material in a very original book.

F. A. PANETH

VERTEBRATES WITHOUT ERYTHROCYTES AND BLOOD PIGMENT

By PROF. JOHAN T. RUUD

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IT is frequently claimed that one of the characteristics of vertebrates is that they have a red blood pigment, hemoglobin. Exceptions are the *Leptocephalus*-larva of the eel, which has no blood pigment until it develops into an elver, and *Petro-myzon*, which has a blood pigment slightly different from that of other vertebrates.

For half a century, however, whalers in South Georgia have known that there are three local species

of fish, namely, *Champscephalus gunnari* Lonnberg, *Pseudochaenichthys georgianus* Norman, and *Chaenoccephalus aceratus* (Lonnberg), all of which have a colourless blood. The Norwegian whalers call them "bloodless fish" (*blodlaus-fisk*).

I first heard about these "bloodless fish" on a visit to South Georgia in 1929; but no specimens were forthcoming, and I did not take them seriously. I was reminded about their existence, however, when Mr. D. Rustad, biologist in the Norwegian Expedition (1927-28), presented me with some photographs of a "white crocodile fish" caught by him at Bouvet Island, mentioning the fact that its blood was colourless. From these photographs Nybelin¹ in 1947 described the fish as a new species, *Champscephalus bouvetensis*, believing it to be distinct from *C. aceratus* known from South Georgia and other west Antarctic islands. Nybelin cites the description communicated to him by Rustad, in which we find the remark: "Blood colourless". Farther on he says about the South Georgia species that it "is said to have colourless blood" (ref. 1, p. 51). So far as I know, this is the first time the fact is mentioned in the literature. (After this was written my attention was directed to a book by L. Harrison Matthews, "South Georgia, the British Empire's Subantarctic Outpost", published in 1931, in which the author on p. 36 mentions the fact that a species of fish with white gills and colourless blood exists in South Georgia.)

I heard about colourless blood in fish again when Mr. Fredrik Beyer, biologist in the Norwegian Bratag expedition (1947-48), returned home with some specimens of *Champscephalus esox* (Günther) taken by him in the harbour of Punta Arenas. In his paper on the fishes from this expedition, Nybelin cites Beyer's description: "The gills colourless on the living animal" (ref. 2, pp. 9-10).

When Mr. Steinar Olsen was sent to South Georgia to conduct some investigations on the "South Georgia ood" *Notothenia rossi marmorata* Fischer, I asked him to look out for the fishes with colourless blood, and he returned in 1951 with some preserved specimens of the fishes and samples of their blood frozen and fixed in formalin.

Prof. P. A. Owren (Medisinsk Avd. A., Rikshospitalet, Oslo) prepared blood smears from these samples and stained with May Grünwald and Giemsa. He found no cells resembling erythrocytes; but a few nucleated cells, presumably lymphocytes, were present. No blood pigment could be demonstrated in these samples, and their fixed condition prohibited a closer study of the blood proteins.

In December 1953, after the whaler *Enn* had completed her international whale-marking voyage at South Georgia, I was able to make some determinations of the oxygen capacity of the colourless fish blood. Steinar Olsen had told me that in the Antarctic midsummer I could expect to catch only one of the three species known to occur in South Georgia, namely, *Champscephalus aceratus*, known to Norwegian whalers as the "white crocodile fish" and to British whalers as the "icefish", probably because it is nearly transparent.

Indeed, I would not have succeeded in catching this species either, were it not for the unfailing help of Mr. Sigvald Sørensen, storekeeper at Husvik Harbour, and of Dr. D. Felix Richards, physician at Leith Harbour. I am indebted to the managers of both whaling stations, Mr. Nils E. Olsen, of Husvik, and Mr. S. L. Bjelland, of Leith, for facilities liberally placed at my disposal.

The oxygen capacity of the blood was determined by the micro-gasometric method described by Roughton and Scholander³, with certain modifications necessary for working on fish blood, kindly communicated to me by Dr. Scholander just before my departure from Norway.

I secured four specimens of *Chaenoccephalus aceratus* in all, the first three shortly after my arrival to South Georgia and before I was fully prepared to make the analyses. My first analysis was made, therefore, on blood which had been stored for some days in a refrigerator. Later I obtained the fourth specimen and could repeat all observations on freshly drawn blood, taken from the ventricle of the heart with a syringe in which the dead-space had been filled with heparin to prevent clotting.

The freshly drawn blood is nearly transparent, with a slight yellowish-white tint. Without the addition of some anticoagulant it clots in the course of two or three minutes to the consistency of a soft jelly.

After being centrifuged for 30 min. at 3,500 rev./min., the plasma is clear as water, and the sediment of white cells constitutes less than 1 per cent of the volume.

No absorption band can be discerned in a spectrum.

Blood smears stained with May Grünwald and Giemsa confirmed the previous observations, that there are no blood corpuscles similar to the erythrocytes of normal vertebrate blood.

Before determining the oxygen capacity, the blood was aerated for 15-50 min. in a container open to the air and revolving slowly around a horizontal axis.

The blood from the first three fish had been mixed and kept in a refrigerator for five days before the oxygen capacity was determined. The colour of this blood seemed to be unaltered and it smelt good, but a little 'fishy'. Four determinations gave an average of 0.67 per cent by volume of oxygen in the range 1.08-0.45.

The average of eight analyses of the freshly drawn blood from the fourth specimen gave 0.72 per cent oxygen by volume (range 0.90-0.54). What was left over from this sample was used as a check on the earlier determinations by keeping it in a refrigerator for five days and then making three further analyses. These gave an average of 0.77 per cent oxygen by volume (range 0.945-0.675), which is slightly more than on the first occasion.

For comparison I determined the oxygen capacity of normal red blood from two other local species of fish, *Notothenia rossi marmorata* Fischer and *Notothenia coriiceps* Richardson. They gave mean values of 5.99 and 6.24 per cent by volume of oxygen, respectively, capacities of the same order as those known from northern fishes.

The oxygen capacity of the blood of *Chaenoccephalus aceratus* is presumably not more than what one would expect to find in the plasma alone of ordinary red blood. It seems evident, therefore, that *Chaenoccephalus aceratus* has no means of taking up oxygen in its blood except by physical solution.

A small sample of the blood was taken back to Norway stored in a refrigerator. From this sample, which was now slightly decomposed, Dr. Ernst Fåyn, of this Laboratory, has determined the iron content according to the method described by Wong⁴. He found less than 1 mgm. per cent iron. This result cannot claim to give the true value of the iron

content of the blood of *Chaenoccephalus aceratus*, since the sample had a minute addition of heparin. Van Dam and Scholander⁵ and others have determined the iron content of the red blood of various species of fish and give mean values of 19.6-28.7 mgm. per cent. The result of Dr. Fåyn's analysis supports, therefore, the view that the blood of *Chaenoccephalus aceratus* is to be considered as a plasma with a moderate content of leucocytes.

I had no opportunity of determining the actual metabolism of *Chaenoccephalus aceratus*. One would expect it to be rather low, and the fish seen alive gave the impression of being quite sluggish compared with other species taken at the same time. It seemed to be very sensitive to lack of oxygen, because as soon as it was landed it made laboured respiratory movements, extending its gill-covers as widely as possible, thus displaying the peculiar yellowish-white colour of the gills. I did not measure the respiratory surface of the gills; but they seemed to be relatively big. Such measurements will be made on the preserved specimens.

It should be noted that *Chaenoccephalus aceratus* attains to 60 cm. or more and can weigh more than 1 kgm. The two other 'bloodless' species known from South Georgia are slightly smaller, *Champsoccephalus gunnari* being about 32 cm. long and *Pseudo-chaenichthys georgianus* about 48 cm.

All three species belong to the family Chaenichthyidae, the characters of which include a naked body and ribs not ossified. According to Norman⁶, the family has nine genera with thirteen species, to which belong the species described by Nybelin from Bouvet Island. Thus thirteen are confined to the Antarctic zone. Only one species is found north of the Antarctic Convergence, namely, *Champsoccephalus acaz*, known from the Patagonian coast and the Falkland Islands, which according to Beyer's observations, mentioned above, also has a colourless blood. It seems very likely that other species, besides the three from South Georgia, the one from Bouvet Island and the one from the Patagonian coast, may have colourless blood, but no information is available.

It is little wonder that the colourless blood of these fish has been overlooked by the scientists who described them, because the red gills of other fishes are soon bleached in museum material preserved in alcohol. It is to be noted that Nybelin's observation of the fact is due to statements made by the scientists who made the catches.

The fact that a good-sized vertebrate can exist without any oxygen-binding blood pigment provokes some interesting questions. Since these fish presumably descend from ancestors with haemoglobin in their blood, one imagines that only in the cold water of the polar regions could a fish survive which had lost its blood pigment. The *Chaenoccephalus* specimens came from water at rather less than 2° C. In the winter farther south the water temperature descends to around -1.7°, and is always well aerated. In winter the whalers at South Georgia catch the 'white crocodile fish' more commonly inshore, so *Chaenoccephalus aceratus* tends probably to avoid the higher temperature found in the flocks in the summer and moves offshore.

Concerning the evolutionary problem raised by these fishes without blood pigment, it is interesting to mention that C. Tate Regan (quoted by Norman⁶) considered that "Antarctica may have long been isolated and that its coasts may have been washed

by a cold sea for a long time, probably throughout the Tertiary Period".

¹ Nybelin, Orvar, *Sci. Res. Norw. Antarctic Exped. 1927-1928 at seq.*, No. 26 Det Norske Videnskaps-Akademi i Oslo, 1-76 (1947).

² Nybelin, Orvar, *Sci. Res. "Bratag" Expedition 1947-48*, No. 2, Publ. No. 18 Fra kommandør Chr. Christensen Hvalfangstmuseum Sandefjord, 1-52 (1951).

³ Roughton, F. J. W., and Scholander, P. F., *J. Biol. Chem.*, 148, 541 (1948).

⁴ Wong, S. Y., *J. Biol. Chem.*, 77, 409 (1928).

⁵ Van Dam, L., and Scholander, P. F., *J. Cell. and Comp. Phys.*, 41, 3, 1-8 (1953).

⁶ Norman, J. R., "Discovery" Rep. 18, 1-104 (1928).

PROF. H. MUNRO FOX, Bedford College, London, writes the following comment on the foregoing article: Prof. Johan T. Rund's study of the fishes with colourless blood will be a most interesting surprise to most zoologists, although a few knew of their existence¹. The fact that there are fishes lacking haemoglobin is not, however, quite so astonishing as appears at first sight, for the following reason. More than thirty years ago Maurice Nieuvoort² showed experimentally that carp, pike and eels remained alive for four hours, "*pas très incommodes*", in water through which a mixture of air with 2 per cent carbon monoxide was bubbled. Such a gas mixture would quickly kill a man. The haemoglobin in the fishes' blood was found to be about 90 per cent in the state of carboxyhaemoglobin, that is, incapable of transporting oxygen. The conclusion, although not drawn by Nieuvoort, is that many fishes when swimming quietly get enough oxygen for their needs in solution in the blood plasma, and they probably only require an additional supply with the aid of haemoglobin when they are moving actively. Their haemoglobin is an emergency precaution and the 'ice fish' do without this luxury. Doubtless, however, haemoglobin is not a luxury but a necessity in the blood of such fishes as mackerel, which cannot get enough oxygen without swimming rapidly through the water³.

¹ Matthews, L. Harrison, "South Georgia", p. 26 (Wright and Marshall, 1931).

² Nieuvoort, M., *C.R. Soc. Biol. Paris*, 99, 1228 (1923).

³ Hall, F. G., *Amer. J. Physiol.*, 98, 417 (1930).

NEW SURGE GENERATOR AT THE NATIONAL PHYSICAL LABORATORY

By R. S. J. SPILSBURY

ON April 21 a ceremony was held at the National Physical Laboratory to inaugurate the new surge generator installed by H.M. Ministry of Works for the use of the Electricity Division of the Laboratory. The equipment was put into action by Sir Edward Bullard, director of the Laboratory, and caused to discharge across a chain of forty-five glass suspension insulators, the total length between end fittings being 20 ft. Thanks to the courtesy of the main contractors for the equipment, Messrs. Ferranti, of Hollinwood, the inauguration was followed by a luncheon, at which Sir Edward made a short speech, and Sir Vincent Z. de Ferranti replied.

The need for surge generators arises, of course, from the hazards to which overhead electricity transmission lines, and the transformers, cables, etc., connected to them, are subjected when lightning

strikes the conductors or their supporting towers. The effect is to raise the voltage of the line, in a time of the order of a millionth of a second, to a value limited in practice only by the breakdown voltage of some of the insulation, such as air gaps or strings of porcelain insulators: this voltage may be of the order of a million volts for 275-kV. lines. Similar effects occur when switches are operated, though these surges are usually less serious. The voltage step imposed travels along the line without much attenuation, and in due course reaches a transformer or cable. The effect on transformers is particularly serious, since the steep front of the travelling voltage wave causes most of the voltage to appear across the first few turns of the winding, and so to place a stress on the inter-turn insulation many times that which it has to withstand in normal service.

The increasing use of overhead transmission lines and the occurrence of breakdowns due to the causes mentioned above produced, many years ago, a demand for tests designed to simulate the effects of natural lightning, and the surge generator, in conjunction with a high-speed cathode-ray oscillograph, provided the necessary tool. Briefly, such a generator consists of a series of high-voltage condensers which are charged, through fairly high resistances, by a direct-current source of suitable polarity—the effects of positive and negative surges are not, in general, the same—and are then connected in series by the breakdown of air-gaps. The breakdown is initiated by applying a controlled voltage surge to one of the gaps. In this way a voltage impulse, reaching its peak in perhaps a millionth of a second, and decreasing to half this value in about 50 millionths of a second—values which have been internationally agreed as reasonably representative of those which occur in practice—can be applied to a test object.

The National Physical Laboratory has possessed apparatus of this type, built by its own staff, for many years, the open-circuit voltage of the generator being 2 million, and the energy stored in the condensers 20 kilowatt seconds, and, until recently, this has been adequate. Some little while ago, however, it became clear that new equipment was needed; partly because transmission voltages are rising—275 kV. is in use in Great Britain and 380 kV. on the Continent—and partly because the condensers that form the heart of the generator, and are heavily stressed in service, were showing signs of deterioration. It was therefore decided to install new plant, and to design this for the highest voltage that the size of the building allowed—5.2 million volts—so that it would be adequate for the foreseeable future. The dimensions of the main high-voltage laboratory are 120 ft. × 60 ft. × 45 ft. clear height; even so, it was necessary, in order to obtain adequate clearance, to excavate a large pit 8 ft. deep, in which the generator stands.

The apparatus has eight stages, each charged to a voltage of up to 400 kV. by a transformer and metal rectifier: the stored energy is 77 kW. Each stage consists of two condensers in separate housings, the stage capacitance being 0.15 microfarad. The circular ribbed porcelain housings, with empty porcelains to act as stage insulators, are assembled into a strong four-column structure, which also supports the 50-cm. diameter spheres that form the electrodes of the various air-gaps, and resistors for controlling the shape of the voltage impulse. A condenser is provided to form the high-voltage section of a capacitance voltage-divider, from which

the scaled-down voltage that is applied to the recording oscillograph is obtained.

A glass-fronted chamber, built out into the laboratory at the level of the first floor, houses a desk which incorporates all the controls, and the indicators for safety interlocks, etc. The controls include means for varying the voltage, reversing polarity, setting the inter-stage gaps to a value appropriate for the stage voltage in use, firing the generator at the desired instant, and earthing the apparatus between tests. A device is provided for starting the 'time-sweep' of the oscillograph just before the generator fires, so that the front of the wave is properly recorded. The oscillograph is housed in a steel shield near the control desk.

The new generator is believed to be the largest in Great Britain, and it should be a valuable addition to the research and testing equipment of the Laboratory.

harvest of results brought him a well-earned Ph.D. in 1950. The most significant discovery was the recognition of the fact that, although the complex bears the hall-marks of an intrusion (for example, it transgresses the structures of the country rocks and shows internal vertical lineations), the materials of the marginal part of the granitic mass are transformation products of the adjacent country rocks. Rutledge also made an important tectonic study of the Fannich Forest area in the Scottish Highlands. More recently he was engaged on similar tectonic and petrogenetic problems in New South Wales.

A geologist of initiative and distinction, Harold Rutledge was fearless in spirit and endowed with great vitality and power of endurance. His sudden death, just as he was approaching a period of solid achievement, is indeed a grievous loss. Deep sympathy will be felt for his widow and four-year-old son.

ARTHUR HOLMES

OBITUARIES

Dr. Harold Rutledge

DR. HAROLD RUTLEDGE was among the ill-fated passengers who lost their lives when an air-liner en route to London from Sydney crashed at Singapore on March 13. The news of his tragic death at the early age of thirty-three has deeply shocked all who knew him, and not least his many geological friends in Britain and Australia. Born on December 15, 1920, at Fairfield, Darlington, he was educated at Stockton Secondary School before entering Bede College in 1939 as a student of the University of Durham. He was elected senior student of the Science Laboratories at Durham, 1941-42, and obtained a first-class honours degree in geology in 1942. He was no less distinguished in university athletics and games—becoming a rugger blue—while his obvious capacity for leadership was recognized by his appointment as sergeant-major of the S.T.O. After graduation, Rutledge entered the Royal Engineers and was soon seconded to the Royal Bombay Sappers and Miners, 1943-46, with whom he saw active service in the Burma campaign, eventually with the rank of captain.

On demobilization, Rutledge spent nearly a year on the staff of the Atomic Energy Division of H.M. Geological Survey; but wishing to return to academic life, he accepted appointment in 1947 as assistant lecturer in geology at Nottingham. A year later I invited him to join the staff of the Grant Institute of Geology, University of Edinburgh, as lecturer in geology, and there he remained until 1952, when he was appointed senior lecturer under Prof. C. E. Marshall at the University of Sydney. He was an outstanding success as teacher and lecturer, clear and vigorous in style and able to inspire in his students the enthusiasm which he brought to all his interests. During his Edinburgh days he joined the Territorial Army as captain in the Military Geology Group (Royal Engineers) and attended manoeuvres in Germany and elsewhere.

Rutledge's main research work was concerned with the structure and petrology of part of the plutonic complex of Loch Doon (Galloway) and its metamorphic aureole. His active interest in this area began while he was still an undergraduate; but it was not until he returned to university life that his wish to study it in detail was fulfilled. The first

Prof. Marston T. Bogert

By the death of Marston Taylor Bogert at the ripe old age of eighty-six, American and international chemistry has lost one of its most charming and effective personalities. Bogert was educated at Columbia University, where later he became professor and finally professor emeritus of organic chemistry. His main chemical interests lay in the synthesis of heterocyclic compounds such as the quinazolines and thiazoles. He also conducted many investigations on the preparation of derivatives of such aromatic compounds as pyrogallol, thiophene, terephthalic acid, phenacetin and cinnamic aldehyde. He was interested in pharmaceuticals and perfumes, and among the four hundred papers in his name one finds such interesting topics as the relationship between odour and molecular structure.

Bogert was president of the American Chemical Society during 1907-8, and it was during this period that he, together with O. L. Parsons, then secretary of that Society, succeeded in forming the first divisions within the American Chemical Society—a far-sighted political act which in these latter years has undoubtedly greatly assisted in maintaining the cohesion in that vast organization. During the First World War, Bogert was invited to Washington to organize and serve as first chairman of the Chemistry Committee of the National Research Council. He was elected president of the Society of Chemical Industry for the year 1912, and in the years 1918-19 he served as colonel in the U.S. Chemical Warfare Service. After the Second World War, Bogert devoted much of his time and energy to the resuscitation of the International Union of Chemistry, and he was, in fact, the first American citizen to be elected president of that body.

Although somewhat feeble physically and attended by a nurse, Bogert went through the lengthy and trying public functions which attended the seventy-fifth anniversary meeting of the American Chemical Society in New York in 1951. As a public speaker or toastmaster, he displayed a mind capable of much wit and charm, and at scientific dinners the wise always attempted to get a seat near the man with the mauve tie, a sign that Bogert had attended the New York dinner in honour of Sir William Perkin. His loss will be felt by his many friends on both sides of the Atlantic.

ERIC K. RIDGAL

NEWS and VIEWS

Royal Society: New Foreign Members

THE following have been elected foreign members of the Royal Society: Karl von Frisch (Munich), distinguished for his work on the physiology of the chemical and visual sense organs of animals, especially insects and fish; Otto Loewi (New York), distinguished as being the first to demonstrate the transmission of the effects of nerve impulses by the release of chemical transmitters; Karl Manne Georg Siegbahn (Stockholm), distinguished for his work on the accurate measurement of X-ray wave-lengths, both by crystal and diffraction-grating methods; Otto Struve (Berkeley, California), distinguished for contributions to observational astrophysics, particularly of double stars.

Electrical Engineering in the University of Wales:

Prof. Emrys Williams

PROF. EMBYS WILLIAMS, of the University College of North Wales, Bangor, has accepted the new chair of electrical engineering at University College, Cardiff, from October 1. Prof. Williams is a native of Liverpool and studied at the Liverpool Institute and the University of Liverpool, where he was awarded the Ph.D. degree for research on electro-acoustics. During 1934-37 he was a member of the scientific staff of the Research Laboratories of the General Electric Company, and was engaged on electro-acoustics, television and carrier telephony. For the following ten years he was lecturer in electrical engineering in King's College, Newcastle upon Tyne (University of Durham), being responsible for the light-current work of the department under Prof. J. C. Prescott. During this time he was associated with Messrs. A. Reyrolle and Co., switchgear manufacturers, Hebburn-on-Tyne, and was chairman of the North-eastern Radio and Measurements Group of the Institution of Electrical Engineers. He is the author of a well-known text-book on valve circuits. Prof. Williams has held the chair of electrical engineering at Bangor since 1947. Although founded largely as a result of a bequest earmarked for hydro-electricity and kindred subjects, the Department of Electrical Engineering at Bangor has in recent years been interesting itself more and more in the light-current branch of the subject. The departure of Prof. Williams coincides with the decision to specialize in this branch, sometimes loosely termed electronics, and a chair of 'applied electricity', within the Department of Physics, is to replace the chair of electrical engineering at Bangor.

Engineering in the University of Wales will thus in future be concentrated at the Cardiff and Swansea Colleges. The new course in applied electricity at Bangor will cover the rapidly growing developments in those parts of light-current electricity which occupy an intermediate position between physics and electrical engineering. Prof. Williams's move to Cardiff will be much regretted by his Bangor colleagues, where his good fellowship and capacity for clear thinking will be greatly missed. His future colleagues at Cardiff welcome him most warmly to his new field of activity, where he may be expected to play a prominent part in the development of education and research into the applied sciences.

Royal Aeronautical Society: Awards

THE following awards have been made by the Royal Aeronautical Society: *Honorary Fellowship Diplomas*, to Sir A. H. Roy Fedden and Sir Frank Whittle; *Society's Gold Medal*, which is the highest honour that the Society can confer, to Sir Geoffrey Taylor, for his outstanding contributions to aeronautical science; *Society's Silver Medal*, to Prof. W. J. Duncan, for his outstanding work in aeronautical science and education; *Society's Bronze Medal*, to Mr. H. B. Howard, for his long and valuable work on aircraft structures; *British Gold Medal*, to Mr. A. G. Elliott, for his outstanding practical achievement in the design and development of aircraft engines; *British Silver Medal*, to Mr. R. Brie, for his practical contributions to the development of rotary-wing aircraft; *George Taylor (of Australia) Gold Medal*, to Mr. V. A. M. Hunt, for his paper on air-traffic control to-day and to-morrow; and *Simms Gold Medal*, to Mr. E. D. Keen, for his paper on integral construction—its application to aircraft design and its effect on production methods.

Iron and Steel Institute: Awards

THE following awards have been made by the Iron and Steel Institute: *Bessemer Gold Medal* for 1954, to Dr. T. P. Colclough, technical adviser to the British Iron and Steel Federation, in recognition of his distinguished contribution to the development, in theory and practice, of the manufacture of iron and steel; *Sir Robert Hadfield Medal* for 1954, to Dr. A. H. Leckie, technical officer to the Iron and Steel Board and until recently with the British Iron and Steel Research Association, in recognition of his valuable contributions to research in steelmaking; *Andrew Carnegie Silver Medal* for 1953, to G. R. Bish, of Enfield Cables, Ltd., and formerly of University College, Swansea, for his report (written in conjunction with Prof. H. O'Neill, who was not eligible) on the deformation of austenite in relation to the hardness characteristics of steel (*J. Iron and Steel Inst.*, 173, 398; 1953); *Williams Prizes* for 1953 (two of £100 each), to A. H. Norris, of John Lysaght, Ltd., Scunthorpe, for his paper on soaking pit practice at the Normanby Park steelworks of John Lysaght, Ltd. (*J. Iron and Steel Inst.*, 173, 353; 1953), and to E. R. S. Watkin, of the Appleby-Frodingham Steel Co., for his paper on railway traffic of the Appleby-Frodingham steelworks (*J. Iron and Steel Inst.*, 173, 1; 1953); *Ablett Prize* for 1953, to F. Starkey, of Buckley and Taylor, Ltd., Oldham, for his paper on guides and strippers for modern rod and bar mills (to be published later).

Heavy-Water Atomic Reactor for Harwell

WORK is beginning on a new atomic reactor at the Atomic Energy Research Establishment, Harwell. This will be the fourth pile to be built at the Establishment and the first in Great Britain using heavy water as a moderator. For the past six years Harwell has had available two piles, BEPO and GLEEP. They have been used for research, and in particular for work in connexion with the design of the piles producing plutonium now in operation at Windscale and the newer nuclear energy electricity generating station now under construction at Calder Hall. However, the more advanced types of power pile now under consideration are likely to operate at a much higher intensity, and this should lead eventually to a reduction of capital costs and lower overall costs of

reactor operation. Accordingly, it has been decided to build at Harwell, in addition to the zero energy fast fission reactor (which has now been operating for some two months), a small research reactor operating at a very high intensity to permit the necessary experimental studies to be carried out. The new pile will also make it possible to produce certain radioactive isotopes such as cobalt-60, which cannot be made with sufficient specific activity in BEPO. The use of heavy water as a moderator enables the required facilities to be obtained at a lower capital cost than would be possible with a graphite-moderated system. The reactor will use as fuel highly enriched uranium which will be supplied from the diffusion plant operated by the Atomic Energy Industrial Group at Capenhurst. General design of the new pile is being undertaken by the Atomic Energy Research Establishment, while detailed design and provision of reactor components will be a responsibility of Messrs. Head Wrightson Processes. The Ministry of Works is undertaking civil and general mechanical work in connexion with site services, building and installation.

The Organization of Pure and Applied Science

THE address on pure and applied science and their appropriate forms of organization, which Prof. M. Polanyi delivered last July in Hamburg at the Congress on Science and Freedom (see *Nature*, 172, 445; 1953), has now been published as Occasional Pamphlet No. 14 by the Society for Freedom in Science (pp. 13, 1953; 1s. 3d.; from the Society at the Department of Zoology, University of Oxford). Empirical science, he points out, is based on observations, while technology is a collection of inventions. Not all empirical knowledge forms part of science, and only a part of technology is applied science. While empirical technology is necessarily unsystematic, it can be an important source of information worthy of scientific study. Such technically justified science, like systematic technology, founded on an application of science, forms a field of study lying between pure science and pure technology. The principles for the proper organization of research in pure science are determined by the distinctive characteristics of pure science; and since all real scientific discovery must show originality, expanding the system of science in an unexpected way, scientific discovery is an essentially independent task. Scientific research nevertheless must rely for financial support on public subsidies, and for the effective advancement of science as a whole the individual independent research tasks must be co-ordinated through a spontaneous system operating under the control of scientific opinion. Within this framework the function of the public authorities is to supply the scientist whose work is appreciated by public opinion with the means for pursuing his own interests in science, giving preference to those who have the greater prestige in science. The study of technologically justified branches of science should be cultivated under the auspices, and at the expense, of special interests served by the inquiry, but without drawing away too much talent from the pursuit of scientific inquiries of universal interest. The study of systematic technology should be organized like the advancement of pure science. Finally, Prof. Polanyi urges that, when the State establishes institutions for the cultivation of science, it recognizes a realm of independent ideas and independent men. It admits that the requirements of this realm demand con-

sideration equally with the political and material interests of the society guarded by the State, and by implication the State is committed to foster the advancement of science under the guidance of its own accepted scientific leaders.

Corrosion Prevention and Control

THE appearance in March of the first number of a new journal, *Corrosion Prevention and Control: Engineering—Equipment—Technology* (1, No. 1, March 1954; published from Holland House, 140 Cromwell Road, London, S.W.7; 30s. or 5 dollars for one year, and 75s. or 12.50 dollars for three years), is in line with the increasing interest being shown in the subject of corrosion prevention. This interest has already found expression in the formation in 1951, by the Society of Chemical Industry, of a Corrosion Group to encourage the presentation and publication of original papers and of reviews. The new journal is, however, the first in Britain to be devoted exclusively to the subject of corrosion, the aim being to present accounts of new developments in a form suitable for rapid appraisal by engineers, chemists and metallurgists who are concerned with the practical application of corrosion knowledge. In the first number this object has certainly been achieved. The editorial comment is of a high standard. Articles refer to cathodic protection, zinc anodes, metal pre-treatment, protection by paints and resistant plastics. Under the heading "Technical Review" are listed forty-one items relating to progress in corrosion prevention, while abstracts of twenty-three corrosion patents are given in a separate section. With two exceptions, all the articles are anonymous. The sixty-four pages in the first number include ten and a half pages of advertisements. It would be preferable, however, to paginate all advertisement matter separately. The publication of future issues of the new journal will be awaited with interest.

Collected Reprints of the National Institute of Oceanography

THE National Institute of Oceanography in Great Britain, following the example of the oceanographic institutions of the United States, has issued the first volume of the "Collected Reprints" of many of the publications of its staff (pp. vii + 61, December 1953; from the Institute, Wormley, Godalming, Surrey). The papers in question were originally published during the years 1949–53 inclusive, and are on many branches of both physical and biological oceanography, including the design and operation of instruments of observation. In accordance with the deliberate policy of the Institute, these papers appeared in a wide range of journals, few of which are of a specialized oceanographic character and some of which cater for the general reader. The alternative would have been for the Institute to publish its own journal, and indeed it does continue to publish the "Discovery Reports", which deal with work based mainly on the observations and collections of the former Discovery Committee, or closely related to that work. But the method of publication chosen for the newer work brings this to the notice of readers outside the field of oceanography, and gives the staff of the Institute the benefit of criticism from those using similar techniques. For oceanography is only the application of the various basic sciences to the acquisition of knowledge of the oceans. Of the papers written for the general reader, a good pro-

portion are by the director of the Institute, Dr. G. E. R. Deacon, and these serve an excellent purpose in popularizing the subject. It is very unlikely that anyone interested in the work of the Institute would have easy access to the majority of the journals used by the staff, and so the issue of collected reprints is specially welcome.

Oundle School Natural History Society

THE annual report for 1953 of the Oundle School Natural History Society, edited by B. W. H. Coulson and I. F. Thomas, has recently been published. It is disappointing to read that "Too much is still left to a few keen members and . . . how few members help by providing records". This remark does not necessarily indicate a lack of interest in practical natural history, for all too often the most enthusiastic fail to record their work, which is a pity from several points of view. Three lectures, a series of short talks and a conversation were some of the indoor activities of the Society during the year, and Oundle School took part in the annual exhibition of the Association of School Natural History Societies at the British Museum (Natural History) on November 7. Among the reports of groups are: mammals, in which a study of bats in Oundle is suggested; birds, recording rarities, phenology and ringing; fish—all coarse, freshwater species; Crustacea; Arachnida; Lepidoptera; Ephemeroptera; Hemiptera; Diptera; Annelida, including physiological experiments on leeches; flowering plants, including phenology, new species and ecology; fungi. Notes are also included in the report on the biology of a lake and a fen together with records of various animals kept in the laboratory. Oundle School is clearly taking advantage of its excellent position for field natural history, and is not lacking in enthusiasm. It is to be hoped, therefore, that the members of its Natural History Society will heed the remarks of the editors of the annual report concerning lack of written records, for this is very important.

Flora of the Belgian Congo

THE fourth volume of the "Flore du Congo Belge et du Ruanda-Urundi" (Publ. Inst. Nat. pour l'Étude Agron. du Congo Belge, pp. 314, with map and line drawings; Brussels, 1953) deals with the Spermatophytes, Papilionaceae (Part I), of this rich and varied floristic region. Accounts of the tribes Sophoreae, Genisteae, Trifolieae and Lotaeae, each contributed by a different author, are here given; the other tribes of this order will be dealt with in two subsequent volumes. Analytical keys are provided for the tribes, genera and species; the genera and species being described in detail (in French) with notes on their distribution and habitat and occasional illustrations. The publishers are to be congratulated on the clarity of the arrangement and text.

Arid Zone Research

THE general conference of Unesco at its sixth session held in Paris in 1951 authorized the Director-General "to collect and disseminate information on research being carried out on problems of the Arid Zone and on the organizations, scientists and engineers engaged in such research". As a result, the secretariat undertook a survey among the member States of the institutions primarily devoted to scientific and technical research on problems of arid and semi-arid areas. A directory has now been published which gives detailed information about

these institutions. The ninety institutions listed are located in sixteen countries and seven dependent territories spread over the five continents of the world. Copies of the directory can be obtained from H.M.S.O., price 8s. 6d.

British Institution of Radio Engineers: Convention in Oxford

THE third post-war convention of the British Institution of Radio Engineers will be on industrial electronics and will be held in the University of Oxford during July 8-12. The Institution's Clerk Maxwell Memorial Lecture will be delivered in the Clarendon Laboratory, Oxford, by Sir John Cockcroft, director of research, Atomic Energy Research Establishment, Harwell, on the evening of July 8. More than thirty papers will be presented at the six sessions, which will be as follows: industrial applications of electronic computers; industrial applications of X-rays and sonics; nucleonic instrumentation and application; electronic sensing devices (transducers); process control; and industrial aids to production. The registration fee for members of the Institution is 10s. 6d. a day or £1 11s. 6d. for the whole convention (for non-members, £1 1s. and £3 3s., respectively). Accommodation may be reserved at Christ Church, Oxford. A detailed programme and reservation forms can be obtained from the Secretary of the Institution, 9 Bedford Square, London, W.C.1.

South-Eastern Union of Scientific Societies: Congress in Maidstone

THE fifty-ninth annual congress of the South-Eastern Union of Scientific Societies will be held in the Museum and Art Gallery, St. Faith Street, Maidstone, during June 10-13. After his induction on June 11, the new president of the Union, Dr. Glyn Daniel, will give an address on "The Art of Megalith Builders". The Union is divided into archaeology, botany, geology and zoology sections, and the individual presidents of the sections and the titles of their addresses will be as follows: *Archaeology*, F. C. Elliston Erwood, on the present state of monastic archaeology in Kent; *Botany*, J. E. Lousley, on the amateur botanist in 1954; *Geology*, H. E. P. Spencer, on the Pleistocene period and work for the amateur geologist; *Zoology*, Dr. G. E. Newell, on animal zones of the North Kent coast. Further information can be obtained from the honorary local secretary for the meeting, L. R. A. Grove, Museum and Art Gallery, St. Faith Street, Maidstone.

Physical Society: Summer Meeting

THE annual summer meeting of the Physical Society will take the form this year of three open lectures (no ticket of admission being necessary), given in connexion with the General Assembly of the International Union of Pure and Applied Physics, and will be held at the Royal Institution, 21 Albemarle Street, London, W.1, on July 7 and 9 at 4.30 p.m. and on July 13 at 2.30 p.m. The lectures will be as follows: fields and particles, by Prof. J. A. Wheeler (Palmer Physical Laboratory, Princeton University); the European Organization for Nuclear Research, by Prof. E. Amaldi (Guglielmo Marconi Institute of Physics, Rome); and microwave experiments in the physics of solids, by Prof. C. Kittel (University of California, Berkeley).

Easterfield Medal of the New Zealand Section, Royal Institute of Chemistry

THE New Zealand Section of the Royal Institute of Chemistry has instituted a new silver medal, to be known as the Easterfield Medal, in honour of the late Sir Thomas Easterfield, the first professor of chemistry in Victoria University College, Wellington, and later the first director of the Cawthron Institute. The Medal will be awarded every two years to a New Zealand chemist less than thirty-five years of age who has carried out research work of outstanding quality and originality, the major portion of it being done in New Zealand. The first award will be made this year, and further details can be obtained from the honorary secretary, New Zealand Section, Royal Institute of Chemistry, P.O. Box 250, Wellington, C.I.

Royal Institution: Officers

At the annual meeting of the members of the Royal Institution, held on May 1, the following officers were elected: *President*, Lord Brabazon of Tara; *Treasurer*, Dr. L. H. Lampitt; *Secretary*, Mr. S. Robson; *Managers*, Mr. E. R. Davies, Sir Walter Drummond, Sir Alfred Egerton, Mr. H. S. Gibson, Mr. A. C. Hartley, Mrs. H. K. Hawkes, Prof. A. V. Hill, Mr. L. B. W. Jolley, Dr. H. Lowery, Mr. A. J. Philpot, Mr. W. E. Schall, Mr. P. H. Schwarzschild, Sir George Thomson and Mr. Frank Wakeham; *Visitors*, Mr. W. W. Abson, Mr. F. G. Brown, Dr. H. K. Cameron, Mr. A. D. R. Caroe, Mr. A. H. Ewen, Prof. James Greig, Wing Commander G. e. Hughes, Dr. G. M. Lees, Prof. Kathleen Lonsdale, Mr. Arthur Marshall, Mr. M. M. Melnsky, the Hon. Philip Samuel, Dr. P. C. Spensley, Mr. W. R. Stevens and Dr. Norman Stuart.

Royal Photographic Society Exhibition of Under-water Photography

AN exhibition of photographs taken under water has been arranged by the Royal Photographic Society and will be on show in its house at 16 Princes Gate, London, S.W.7, until May 29 (Sundays excepted), admission free. It comprises about a hundred photographs, in monochrome and colour, of subjects by Commandant Jacques-Yves Cousteau, Henri Broussard, Dimitri Ribikoff, and Robot-Berning and Co., and members of the Under-water Explorers Club. Other items include photographs from Marconi's Wireless Telegraph Co., Ltd., and Siebe Gorman and Co., Ltd., taken off the monitor screen during under-water television operations. The Royal Naval Scientific Service has contributed a special section of fifty prints, showing propeller studies, wreck surveys and experimental techniques.

Earthquakes during February

THERE were some twenty-six strong earthquakes during February, twelve of which had instrumental magnitude 6 and greater. The greatest two had instrumental magnitude $7\frac{1}{2}$ and occurred on February 1 near the Volcano Islands (lat. $24\frac{1}{2}^{\circ}$ N., long. $142\frac{1}{2}^{\circ}$ E.) and on February 11 in Ningxia Province, China (lat. $39\frac{1}{2}^{\circ}$ N., long. 101° E.), respectively. The shock which did most damage during the month had instrumental magnitude $6\frac{1}{2}$ and an epicentre near lat. $17\frac{1}{2}^{\circ}$ N., $92\frac{1}{2}^{\circ}$ W., causing extensive property damage at Chiapas in Mexico. Two earthquakes occurred at a focal depth of 600 km., the first being on February 14 near the Fiji Islands, and the second on February 20 in the Flores Sea. Reports were received from the

United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association, Durham, Lwiro (Belgian Congo), Pasadena, Strasbourg, Toledo and Uccle.

Announcements

WE regret to announce the death on April 25 of Lady Mary Lilian Boyd Dawkins, widow of Sir William Boyd Dawkins, aged ninety.

THE Council of the Royal Society of Edinburgh has awarded the Keith Prize for the period 1951-53 to Dr. D. E. Rutherford, Department of Mathematics, University of St. Andrews, for his paper, "Some Continuant Determinants arising in Physics and Chemistry", and other publications in the *Proceedings* of the Society.

THE first Dickinson Memorial Lecture of the Newcomen Society will be delivered by Prof. Charles Singer in the Science Museum, London, S.W.7, on May 12 at 6 p.m. The Lecture is to be a biennial one.

At the annual meeting of the Zoological Society of London on April 29, Sir Landsborough Thomson was elected president in succession to Lord Alanbrooke. Dr. T. C. S. Morrison-Scott was elected treasurer, and Lord Chaplin secretary. New members of Council are Captain K. Caldwell, Mr. A. Ezra, Lord Forester, Dr. H. W. Parker, Mr. Peter Scott and Mr. S. Wilson Kitchen.

MR. J. E. CUMMINS, chief scientific liaison officer, Australian Scientific Liaison Office, London, is returning to Australia after six years in London. He will be succeeded by Mr. Walter Ives, who is at present secretary (agricultural and biological sciences) of the Commonwealth Scientific and Industrial Research Organization, Melbourne.

THE Minister of Transport, the Right Hon. Alan Lennox Boyd, will open the new research laboratory and proving ground of the Motor Industry Research Association at Lindley, near Nuneaton, Warwickshire, on May 21.

AN exhibition on "Dry Rot and Woodworm" will be opened at the Royal Sanitary Institute (90 Buckingham Palace Road, London, S.W.1) on May 12 by the Right Hon. Sir David Eccles, Minister of Works. The exhibition is being presented in collaboration with the Department of Scientific and Industrial Research and the Central Office of Information, and will remain open until July 17.

THE British Society of Rheology is holding a conference on "Rheology in Mechanical Engineering" in the Mechanical Engineering Research Laboratories, East Kilbride, near Glasgow, during June 10-12. The conference will be free and open to anyone interested in this field. Application forms, to be returned before May 15, can be obtained from Dr. D. P. Feltham, Flat H.12, Sloane Avenue Mansions, London, S.W.3.

THE Committee on Vacuum Techniques is holding a symposium during June 16-18 at the Berkeley-Carteret Hotel, Asbury Park, New Jersey. About twenty-five papers will be read, discussing nomenclature and standards; new equipment and instruments; fundamental developments in vacuum technology; methods and techniques; applications; and processes. Persons and organizations interested in attending the symposium should write to the Committee on Vacuum Techniques, Box 1282, Boston 9, Mass.

MYXOMATOSIS IN RABBITS IN GREAT BRITAIN

THE Advisory Committee on Myxomatosis in Rabbits, appointed in 1953 by the Minister of Agriculture and Fisheries and the Secretary of State for Scotland, has now issued a report* which describes the history and nature of this disease, its present distribution in Great Britain, the protection of domesticated rabbits from it, the harm done by rabbits to agriculture and the present recommendations of the Committee with regard to the disease. Myxomatosis was first reported in 1898 from Montevideo. It is a disease caused by a virus which, so far as we know at present, affects rabbits only. Man, domesticated and other animals cannot be infected with it. It is transmitted purely mechanically to rabbits by the fleas, lice, mosquitoes and mites that suck the blood of the rabbit, and these blood-sucking arthropods act just as a pin infected with the virus might. An infected pin may remain capable of transmitting the virus for twelve days, and the mouthparts of a blood-sucking arthropod may remain infective for twenty-five days. The disease has been used successfully in France and Australia for killing large numbers of rabbits, and the benefit to agriculture is already evident. Recently, the disease has spread to Luxembourg, Belgium, Germany, the Netherlands and Spain. During 1936-38 attempts were made to establish the disease among the rabbits on Skokholm Island, off the Pembrokeshire coast, but these failed. In 1953 the disease broke out in Kent and East Sussex, its source being unknown. Attempts were then made to control its spread; but since then, further outbreaks have been confirmed, and at present six of these have been recorded from Kent, two from East Sussex, three from Essex and one from East Suffolk. The localities where these outbreaks have occurred are shown in a map published with the report.

During laboratory experiments on the disease and in natural outbreaks of it, more than 99 per cent of rabbits infected have died; but those that survive develop an immunity, and it is believed in Australia that rabbits there are becoming immune to the disease and that the very high mortality of rabbits that has occurred in that country is now falling considerably. The development of immunity may therefore prevent the use of the disease for killing rabbits in the future.

The report contains a valuable section on the economics of the wild rabbit. Representatives of the rabbit meat, fur, fur felt and fur felt hat trades have estimated that their trades deal each year with 40 million rabbits. The rabbit meat obtained is worth about £7 million and the skins about £8 million, £3½ million of the latter being represented by exports to the United States. Thus wild rabbits provide in Great Britain a total income of about £15 million a year.

Estimating the cost of the harm that wild rabbits do, the Committee states that nine rabbits eat about as much as two sheep, so that the estimated popula-

tion of Great Britain of about 60-100 million rabbits, which feed largely on agricultural crops and grass, can deprive domesticated animals of a great deal of food. It has been estimated that rabbits may cause losses of the order of 160,000 tons of wheat a year, which is worth £5.2 million, and damage to other cereals of the same order, so that the annual loss in this respect is of the order of £15 million. The most extensive damage is done to grassland, the cost of this being estimated at £21 million a year. Rabbits also damage kale, swedes and other vegetables and also fruit trees; the harm they do to young trees in forestry plantations makes it necessary to protect these trees at an annual cost of about £2 million. The Committee considers, in fact, that the damage done by wild rabbits in Britain costs three or four times the income they bring to the trades dealing in them. In Australia it was estimated that the destruction of rabbits resulted in an increase of rural production worth £50 million during 1952-53 alone.

In order to reach its conclusions the Committee consulted representatives of the animal welfare societies, agriculture, forestry, the trades dealing in rabbits and those concerned with the domestic rabbit. The chairman of the Royal Society for the Prevention of Cruelty to Animals and the chairman of the Committee on Cruelty to Wild Animals are members of the Committee. The animal welfare societies supported the organization of a national campaign to exterminate the wild rabbit by every humane method available as a means of preventing future suffering. The representatives of agriculture and forestry, with the exception of the National Farmers' Union of Scotland, were not generally in favour of deliberate spread of myxomatosis; they felt that, until we know more about the disease, it should be allowed to spread naturally. The representatives of trades dealing in rabbits were concerned about the possible effects of the disease on their trades, and the producers of domestic rabbits sought protection for the domestic rabbit.

The Committee concluded that attempts to control the natural spread of the disease would serve no practical purpose, but that, for humanitarian, legal and other reasons, no attempt should be made to help the spread of the disease or to introduce it where it does not naturally occur. It recommends that the disease should be allowed to run its natural course and that, whenever outbreaks occur, attempts should be made to eliminate survivors of it before they are able to produce numerous offspring immune to the disease. The importation of such live rabbits as the cotton-tail rabbit, which might rapidly become a pest in Great Britain, should be prevented. Special protection should be given to domestic rabbits and information about the best methods of doing this should be distributed. The vaccine which is the only known preventative of the disease should be made available at a reasonable cost to rabbit breeders. The Committee is, meanwhile, watching the disease, and it has started research on it. Further advice will be issued as occasion arises.

G. LAPAGE

* Ministry of Agriculture and Fisheries; Department of Agriculture for Scotland. Report of the Advisory Committee on Myxomatosis. Pp. iv+14. (London: H.M.S.O., 1954.) 6d. net.

NATIONAL COLLEGE OF HOROLOGY AND INSTRUMENT TECHNOLOGY

THE National College of Horology and Instrument Technology was founded in 1947 for the training of technicians in the horological and instrument industries. It is accommodated within the Northampton Polytechnic, London, E.C.1. Shortly after the Second World War the horological manufacturing industry was re-established, and in consequence there was a great need for engineers with a good knowledge of horological theory and of production methods applicable to fine mechanisms. The first course instituted at the College was a three-year diploma course in horology for students over the age of sixteen. The standard of this diploma is of the order of the first part of a degree in engineering, and the curriculum, in addition to covering academic subjects, includes a liberal allocation of time to workshop technology and practice.

During recent years the academic content of the curriculum of the diploma course has been modified somewhat to include instrument technology as well as purely horological work, the remainder of the theoretical and almost the whole of the practical work of the course being found to be admirably suited to the needs of the instrument, as well as the horological, industry. In fact, many students leaving the College obtained posts in the field of instrument design, development and manufacture, even before these modifications were adopted.

The College is equipped with a comprehensive range of general and specialized machine-tools and instruments suitable for almost any branch of fine-instrument and light-engineering production, and the variety of practical work given to students in this course is made as wide as possible. In addition to the specialized facilities in the National College itself, the full resources of the departments of the Polytechnic, including instrument engineering, mechanical and electrical engineering, applied physics, metallurgy and mathematics, are available for students at the College, these departments providing specialist lecturers in individual subjects.

Building extensions costing upwards of £350,000 are at present in hand at the Northampton Polytechnic, and the Instrument Engineering Department has acquired completely new workshops and laboratories. These extend its scope considerably and improve the facilities it is able to offer to the National College in connexion with advanced courses in instrument technology. Extensions to the premises of the National College are also planned which will more than double the space at present available. This space will be devoted to advanced workshops and laboratories for students in both horology and instrument technology.

To co-ordinate the diploma course in horology with training in industry, the British Clock and Watch Manufacturers' Association has sponsored a student-apprentice scheme which supplements the three years spent at the College with a further two years in the works of a member firm. Deferment from military service is normally granted for the full five years and, during the final two years, student-apprentices are expected to continue part-time for a Higher National Certificate. This enables them to qualify for graduateship of one of the engineering

institutions—mechanical, electrical or production—partial exemption being granted on gaining the College diploma.

Extension of Courses

Although many ex-students are employed on instrument engineering with member firms of the British Clock and Watch Manufacturers' Association, the governors of the College are anxious to extend its facilities to other branches of the instrument industry. To this end, discussions have recently been held with the Scientific Instrument Manufacturers' Association to ascertain the types of courses best suited to the industry. An open day was held at the College on March 16 to enable member firms of the Association and other interested persons to inspect the workshops and laboratories, and this attracted some sixty to seventy representatives, many of whom expressed surprise and pleasure at the high quality and variety of equipment.

The two main courses proposed have received wide support. The first proposal is to establish a diploma course in instrument technology having much in common with the present diploma course in horology; with the development of this course, it may well be that horology will take its place as a special branch of instrument technology.

The second proposal is for an advanced course, one year in duration, for postgraduate and post-Higher National Certificate students. At present the instrument industry recruits to its technical and executive grades graduates in physics and engineering. It is found necessary to give these men a period of training in the industry before they are fully competent, and it is suggested that the College could undertake a good deal of this training. The actual length of this course would be one session, eight months in duration.

The curriculum will include a certain number of basic subjects such as applied physics, instrument design, workshop technology, metrology and industrial administration, as well as a number of optional subjects such as advanced mathematics, instrument workshop practice and metallurgy, together with particular branches of instrument theory such as mechanical, electrical, electronic, optical, industrial control and servo-mechanisms. It is envisaged that students holding degrees or Higher National Certificates in physics may well require tuition and practical experience in engineering, production and management subjects, as well as a more detailed knowledge of the technology with which their firm is associated. Students who have taken general engineering will need further tuition in applied physics, production and instrument engineering, while those who have National Certificates in production engineering may wish to study applied physics and perhaps some basic engineering subjects.

National colleges are intended to serve and co-operate fully with their respective industries, and it is therefore essential that approved forms of student-apprenticeships and postgraduate scholarships should be established by the trade associations or the larger firms.

Production and Research

Finally, it should be noted that the interests and facilities of the College are by no means limited to formal instruction. A certain amount of specialized

manufacture is already undertaken where the work involved provides valuable experience for students, and the College is well equipped to accept suitably qualified students for research in various branches of design, development and production applicable to instruments, fine mechanisms, horology, automatic control and so on.

UNIVERSITY COLLEGE OF THE WEST INDIES

DEPARTMENT OF ZOOLOGY

By PROF. N. MILLOTT

THE West Indies have always formed a fruitful area for the prosecution of zoological research, and now, as in the past, excellent work is being done by the Institute of Jamaica and a well-established Natural History Society. In recent years the facilities for such studies have been increased by the establishment of a Department of Zoology in the new University College of the West Indies. Though facilities have been in existence from the inception of the College in 1948, it is only recently that they have been fully realized by the housing of the Department in permanent accommodation.

The Department is situated in the University grounds of some seven hundred acres and is readily accessible, being seven miles from Kingston. It is designed and organized for both teaching and research. As a teaching unit it is responsible for the training of undergraduates for degrees in science, and the intermediate and First M.B. examinations of the University of London, with which the College is privileged to maintain a special relationship. Provision has also been made for the training of post-graduate students for higher degrees.

The buildings were designed by the University College architects, Messrs. Norman and Dawbarn, of London, in conjunction with the head of the Department, and they were completed in October 1952.

Mostly on one level, the laboratories include a large elementary and a smaller advanced teaching laboratory, suitable for the study of systematic

zoology, animal morphology, histology, etc. In addition, there are an experimental laboratory for physiological studies, a small museum, an aquarium room, offices, a photographic dark room and a lecture room. Two research laboratories are provided. All the laboratories are fitted with the usual services, and in addition, both the experimental laboratory and the aquarium room have compressed-air mains. Very shortly a salt-water circulator will be installed in the aquarium room. The furnishings are executed in local woods and were designed and constructed on the University College site.

The laboratories have been equipped and staffed, so far as possible, for a comprehensive study of zoology, rather than for highly specialized studies of particular aspects. In this way it is hoped that the Department will not only be able to give its students an adequate training in the ever-widening sphere of zoology, but will also provide a type of research centre that has long been required in the central Caribbean.

From the first the Department has aimed at encouraging visiting research workers to use its laboratories and in this a real beginning has been made, the Department having already accommodated research workers under the Fulbright scheme and two members of the staff of the University of Glasgow. It is hoped that other institutions and organizations will encourage investigators to use the facilities now available.

Since the beginning, members of the teaching staff of the Department have been actively engaged in research, and the existing programme falls into six main divisions. A study of the Collembola of Jamaican soils is being undertaken, which, initially, will involve the determination of species, and later, studies of population density and distribution. The Nuffield Foundation has generously offered financial assistance for this study. A second division consists of evolutionary studies on snakes and lizards. These have involved investigations of the details of speciation in Jamaican reptiles, comparative anatomical studies including a special study of the retina, and distributional studies which bear on the evolution of higher taxonomic categories and the problem of the origin of snakes. Researches on the thymus of



Zoology Laboratories, University College of the West Indies

reptiles and mammals, particularly primitive forms such as the sloth, are being pursued, and studies are also being made of the anatomy of the rare, beaked whale *Mesoplodon*, two individuals of which were recently washed up on nearby shores. Hitherto undiscovered platytenid ctenophores have raised interesting problems in connexion with their phylogeny and distribution, which are now being tackled in the Department. Lastly, a study of local echinoids has revealed in certain forms a striking sensitivity to light. Since they lack morphologically defined photoreceptors, their mechanism of perception is clearly of great interest and it is being analysed in detail in one species. Rather unexpectedly, the study has yielded interesting results in relation to melanogenesis in this form, and the research has recently received the support of the Rockefeller Foundation.

Visiting workers have undertaken research on the taxonomy and distribution of Jamaican frogs, the effect of thyroid inhibitors on the development, and that of phenylthiourea on the pigmentation, of *Eleutherodactylus*. The bionomics of black widow spiders and scorpions, and the feeding processes of bivalve molluscs, have also been investigated.

The geographical location of the Department is admirable for zoological studies, since the surrounding collecting grounds are readily accessible by good roads. Seaward, some ten miles distant, lies Kingston Harbour with fertile collecting grounds afforded by cays, lagoons, mangrove swamps and innumerable bays and inlets. The north coast of the island with its accessible coral reefs is some thirty miles away, and nearby salt ponds, periodically land-locked, offer a worthy opportunity for ecological studies. Landward, there are areas showing diverse climatic, topographical and geological conditions. From dry plains, mountains clothed in forest rise in succession to 7,000 ft., and most areas are accessible by road.

In general, these areas yield an abundance of animal forms for systematic, ecological and physiological studies. Echinoderms, molluscs and many insects occur in spectacular quantity. The embryologist will find much of interest in the abundant eggs of lizards, geckos and anurans with direct development. For those interested in migration problems, it is appropriate to note that the island is visited not only by migrant birds but also by migrant butterflies.

In the past it was necessary for many visiting research workers to limit their activities largely to collecting and preserving. Such drastic limitations are fortunately no longer necessary, and with the facilities of modern, well-equipped laboratories at their disposal, they may now undertake experimental work no less readily than microanatomical or cytological studies, for the Department is equipped with a comprehensive range of research microscopes, rocking, rotary, sliding and freezing microtomes, kymographs, thermostatic baths, Warburg apparatus, centrifuges, pH meters and a Beckman spectrophotometer.

Finally, it might be mentioned that library facilities are available, not only in the University College, which maintains a first-class library with a microfilm service, but also in the nearby library of the Institute of Jamaica, the staff of which render invaluable assistance to visiting research workers. It is hoped that with these added facilities many zoologists who hitherto have demurred will seize the opportunity of extending the horizon of their animal studies and make use of the facilities that are now available in this supremely fascinating part of the earth.

ATOMIC ENERGY AND MORAL ISSUES*

OWING to the controversial nature of the subject of the moral issues involved in the utilization of atomic energy, two speakers, Prof. Kathleen Lonsdale and Sir George Thomson, were asked to express their views. Their respective methods of approach to the subject, which to a large extent centred around the morality of war, may be summarized in Prof. Lonsdale's words: "I believe that all war is wrong, with whatever weapons, because it is made up of hatred, falsehood and savagery; and because it perpetuates these things. . . . But even if these fundamental objections to war as such are set on one side, I still see in an atomic war, or indeed in any other form of future world war based on scientific super-weapons, a menace to every kind of decency towards one another as human beings that we have painfully achieved throughout the ages. Men die horribly every day; buildings decay and become ruins. What is more horrible is that we ourselves, whether as a means of offence or of retaliation for aggression, should deliberately let loose hell on earth; and that is what atomic warfare would be, no matter how much we may deceive ourselves into supposing that we can ameliorate it with the deep shelters, protective clothing and Geiger counters of civil defence". And in Sir George Thomson's words: "Two societies, or the same society at different times, may with perfect honesty have different codes and judge differently what is right in different circumstances. This is, partly at any rate, the answer to the question of expediency. Right and wrong exist quite independently of expediency. But a code which does not consider expediency is a bad one and will not last. The consequences of acts do matter for moral judgments. It is permissible to indulge in the alkaloid contained in tea, but not in that contained in heroin simply because the long-term consequences are different".

Prof. Lonsdale rejected the doctrine of expediency and appealed to Christianity as a standard by which the rightness or wrongness of any course of action may be judged. "I know," she continued, ". . . it is not possible to prove that there are any absolute standards. Certainly none of us can claim that ours are the only true standards. We know, indeed, that our standards as scientists have at least different priorities from those of some other people. . . . Yet whatever our priorities we do know that there is for us and for all men a 'moral law within', however much we may ignore it or attempt to rationalize it away. Truth, generosity, brotherly love, justice, mercy, integrity are recognized as good, and the Golden Rule 'As ye would that men should do to you, do ye even so to them' still has a compelling force for us which is its own authority. . . . Very often the choice that confronts us in issues relating to Atomic Energy is one between a certain wrong to other people and a possible injury to us or to our nation. When this is so then I submit that it is morally wrong to put a possible or probable wrong to ourselves, or even to those we love, before an absolutely certain injury to others.

* Summary of lectures by Prof. Kathleen Lonsdale, F.R.S., and Sir George Thomson, F.R.S., being the sixth of a series of public lectures arranged by the Atomic Scientists' Association and the Department of Extra-Mural Studies, University of London (see also *Nature*, February 27, p. 336; March 13, p. 477; March 27, p. 573; April 3, p. 621; and April 10, p. 668).

"I believe that this is relevant in our discussion of whether we should build up stockpiles of atomic weapons, even as a means of preserving peace. I want peace to be preserved, not simply because human beings would die horribly in war in which atomic weapons were used, but because in wartime ideals are the first casualties, and because I believe that our democratic ideals would not survive an atomic war. In many ways atomic weapons are intrinsically no different from other weapons—I cannot see that it is more terrible to die in the heat of an atomic blast than to die from the effects of 'napalm', or even from the accidental flare-up of a nylon garment."

Against this point of view, Sir George stated: "I assume, in common with the great majority of Christians of all ages, that though war is an evil there are occasions on which it is the duty of governments to declare it and of their citizens to help to wage it. After all, if one does not assume this there is no specific problem, one would hardly suppose that atomic bombs are right if swords are wicked. The main question is 'what limitations if any should a country place on the methods it is prepared to use in a war it believes just', with as a secondary one 'are these limitations absolute or do they depend at all on what the enemy does?'"

"It seems to me that since the object of fighting is, or should be, to bring about a just peace, a method of war is good in proportion as it is effective and bad in proportion as it causes suffering and economic loss. Its merit is a sort of ratio of the two. Notice, method of war, not weapon. The rifle is perhaps as humane a weapon as man has invented, but if it is used to massacre a defeated population that method of war is a very bad one."

In discussing whether a stockpile of atomic bombs will minimize the possibility of another war, he said: "... the presence of a lot of atomic bombs in the world very substantially reduces the chances of a big war. The United States is very bomb-conscious, and the mere fact that Russia did not force matters in Europe when she was so strong is evidence of her fear. ... There is, I believe, a genuine fear of all-out war and a feeling that in a major war there will be no gallery seats. Even the horrors of the hydrogen-bomb, for which there is no moral defence as a weapon ... , are helping to the cause of peace. I believe attempts at disarmament are futile and that the bitterness and back-biting which abortive disarmament conferences inevitably cause are a real danger to peace".

ACTA HYDROPHYSICA

A NEW JOURNAL OF MARINE PHYSICS

THE first three issues of the new journal, *Acta Hydrophysica**, sponsored by the Institute for Physical Hydrography of the German Academy of Sciences, Berlin, have recently been published and distributed to various addresses on exchange terms though without any indication as to the price at which this well-produced journal can be bought. The three numbers have 139 pages in all (21 cm. x 15 cm. in size), and it is announced by the publishers (Akademie-Verlag, Berlin) that its appearance will be irregular. The journal is edited jointly by Dr. H.

* Deutsche Akademie der Wissenschaften zu Berlin. Institut für Physikalische Hydrographie. *Acta Hydrophysica*, Band 1, Heft 1, 1953. Pp. 56. (Berlin: Akademie-Verlag, 1953.)

Ertel, director of the Institute of Physical Hydrography at the Humboldt University in Berlin, and by Dr. J. Fischer.

If, as may safely be surmised, the purpose of the Institute of Hydrography is to launch a journal devoted exclusively to what would be known in Britain and the United States as 'physical oceanography', then its new publication stands as the first to be confined to that limited but very important field. Because of the inevitable and ever-growing attention to problems within the field of marine physics, a real need has been felt in Britain for a specialist journal in which papers dealing with ocean physics and related meteorology could be published, and good wishes will accordingly be extended to the new German venture.

In an opening paper by H. P. Schmitz on the processes associated with the cooling of inland lakes, it is asserted that relationships hitherto used in connexion with turbulent heat conduction in water are assailable on the grounds that they took no account of the dependence of the water density upon temperature. Though, under frequently occurring conditions, the same equation for turbulent heat conduction is obtained as that arrived at by Wilh. Schmidt, more complicated conditions usually arise—particularly around the temperature of maximum density and through warming. The treatment by Schmitz is unidimensional only, and the conditions where such treatment is permissible are recounted. He deals with the cooling of a column of lake water from surface downwards in the presence of thermal convection and turbulent heat conduction, and derives a connexion between the depth reached by convection and the time of its attainment when surface temperature fluctuations, cooling-rates and the magnitude of the turbulent heat conduction are known. He studies two cases: when there is a night-produced discontinuity layer, and when there is a night-time decrease of vertical temperature gradient—both due to the joint effects of thermal convection and turbulent heat conduction. Finally, he deals with the cooling of a column of lake water the temperature of which lies between those of freezing and of maximum density, and derives a differential equation which serves for the solution whatever be the commencing and the marginal conditions.

An article by J. Fischer on a nomographical process in oceanography presents a new method of using projection paper to carry out certain computations by means of accepted processes of nomography, and applies it to two examples concerned with rainfall. Adrian Steleann writes on the problems posed in lake plankton studies by the degree to which physical factors exert influence and impose distribution limits. He concerns himself with light penetration and temperature gradients in the vertical, the influence of light having only biological significance, whereas temperature has both that and mechanical influence.

Sinking-speed is dealt with in the light of Ostwald's relationship of that quantity to body density, viscosity and body form, and, finally, a discussion is given around the various lake plankton forms characteristic of the four seasons. A 27-page paper by K. Vollbrecht deals with the axial arrangement of quartz grains in sandy sediments. By studying a definite selection of suitable grain sizes, the axial arrangement of quartz grains can (says Vollbrecht) show reliably what the conditions of currents must have been when the sediment was laid down, par-

ticularly as to direction. H. Griesseier and K. Vollbrecht report upon experiments carried out to throw light on the building of bars off river mouths. They discuss the effects due to the slackening of water speed as the cross-section increases, and those due to electrolytic dissociation in sea-water. They also discuss the dependency of bar-building upon the contact of river and sea waters. H. Griesseier writes on the reflexion of sunlight impinging directly upon an agitated water surface, and in the final article, by Joh. Fischer, there is a discussion of a nomographic method for evaluating trigonometrical functions.

J. N. CARRUTHERS

CARNEGIE UNITED KINGDOM TRUST

REPORT FOR 1953

THE fortieth annual report of the Carnegie United Kingdom Trust covers the year 1953*, the mid-year of a quinquennium, and records the opening of new premises for the Scottish Central Library at Fisher's Close, in the Lawnmarket of Edinburgh, on November 5 as the most important event of the year in the field of general educational services. The new building provides space both for the storage of books and for the proper accommodation of the library staff and has been planned with an eye to future expansion.

Out of reports on the employment and training of social workers, issued in 1947 and 1951, proposals have now emerged for the establishment of a one-year course of 'basic' training, designed to follow the acquisition of a general university qualification in social science and providing an alternative to more specialized courses of training now required by many bodies employing social workers. A provisional allocation of £20,000 has been made towards the cost of a four-year experiment. A grant of up to £30,000 has been offered to the governing body of Brentwood, the recuperative centre for mothers, with children, whose family life has gone wrong, maintained by the Community Council of Lancashire to enable extensions and improvements in the accommodation to be made. In October 1953, Dr. John Spencer took up his duties as a director of a social project in Bristol concerned with the establishment of practical means of tackling those stresses and strains which arise in a developing community in the form of delinquency and other disturbances. The project, which is designed to cover a period of five years, will place its main emphasis on encouraging local initiative and on getting local residents to accept more responsibility for their community life, and £25,000 has been allocated by the Trust for this project.

It has been necessary to abandon the residential clinic for difficult children, opened in November 1950; but the Trust has asked the Family Welfare Association to arrange for the preparation and publication, under the title "Family Casework and the Country Dweller", of an account of two experiments in rural casework in Oxfordshire and parts of Northumberland and Durham. A grant of £10,000 over five years on a diminishing scale has been promised to the National Association for Mental Health to establish and maintain a regional office in Leeds.

* Carnegie United Kingdom Trust. Fortieth Annual Report, 1953. Pp. viii+86. (Glasgow: Royal Technical College, 1954.)

ANALYSIS OF THE 1953 STORM SURGE IN THE NORTH SEA

AN analysis of the storm surge of the night of January 31–February 1, 1953, which caused the disastrous floods in eastern England and Holland, has been published by J. R. Roositer (*Phil. Trans. Roy. Soc., A*, 246, 371; 1954). Using tide-gauge data from thirty-three stations around the North Sea, he has eliminated the tidal rise and fall by the methods developed by A. T. Doodson and R. H. Corkan, and has constructed diagrams and charts showing the disturbance of sea-level at three-hourly intervals from 09.00 hr. on January 31 to 03.00 hr. on February 2. The meteorological conditions are shown by a similar series of charts, and from the two it is possible to follow the development of the surge.

The peak of the disturbance was greatest between East Anglia and the mouths of the Scheldt, where the water rose to between 9 and 11 ft. above the predicted levels, and in many places this occurred very near the time of high water. In the extreme south of the region the levels would, no doubt, have been even higher if some of the water had not been able to escape through the Strait of Dover into the English Channel. At the time of maximum disturbance, the mean level of the whole North Sea was raised by 2.2 ft., corresponding to the influx of 15 billion cu. ft. of water from the north. The effect of the earth's rotation was apparent in causing the incoming wave of the surge to be higher on the east coast of Britain, while the outgoing wave was higher on the continental side of the North Sea.

Mr. Roositer has applied the method devised by R. H. Corkan for predicting the surge at Southend, and found that the initial rise and first peak were predicted fairly accurately; but the subsequent course of the surge was about 2 ft. lower than predicted, owing possibly to insufficient allowance being made for the escape of water through the Strait of Dover. After reviewing previous attempts to predict storm surge effects, he suggests several possible improvements in the methods of prediction. The 1953 surge appears to have been caused directly by the northerly winds in and immediately to the north of the North Sea, and there is no evidence of any appreciable external surge component, coming in from the Atlantic, which was a feature of some previous surges.

VELOCITY DISTRIBUTION OF SPORADIC METEORS

IN a paper entitled "The Velocity Distribution of Sporadic Meteors, IV: Extension to Magnitude +8, and Final Conclusions", Mary Almond, J. G. Davies and Prof. A. C. B. Lovell conclude their work on the velocity distribution of 1,095 sporadic meteors. The earlier papers on this subject have been briefly discussed in *Nature*, and the present paper gives a brief summary of the work and apparatus. Previous research on the brighter sporadic meteors gave no indication of an appreciable number with hyperbolic velocity, and now, extending the work to faint meteors of magnitude 8, the same results are obtained. Far from moving in hyperbolic orbits, it was found that nearly 90 per cent of all sporadic meteors must be moving in elliptical orbits with periods of about

two years, and the remaining 10 per cent had velocities close to the parabolic limit.

The work of Hoffmeister and Öpik was largely responsible for the belief, which prevailed for some time, that most of the sporadic meteors moved in hyperbolic orbits, although ten years ago Porter had criticized the methods used in the Arizona Meteor Expedition and had come to the conclusion that hyperbolic orbits were relatively scarce—if, indeed, they existed¹. Although the work at Jodrell Bank Experimental Station of the University of Manchester has vindicated Porter's views, it is admitted that "the results do not exclude the possibility that less than 1 per cent may have hyperbolic velocities—a result which may imply an interstellar origin or may equally well be explained on the basis of perturbation within the solar system". Even if this should be verified in future years, there would still remain a very wide difference between meteors which have speeds just above parabolic velocity and those with high hyperbolic velocities, many more than 160 km./sec., which were found in the Arizona Meteor Expedition.

The conclusions attained by Hoffmeister were based on studies of the diurnal and annual variation of numbers of meteors, and it is interesting to know that in a private communication to Prof. Lovell he has shown how his observations can be reconciled with the more recent results of the survey of sporadic radiants by Prentice and by radio-echo measurements by Lovell. McKinley's results from radio echoes at Ottawa² are in good agreement with those obtained at Jodrell Bank, and all those who took part in this important programme must be congratulated on their perseverance and on the important results obtained. These have established practically beyond doubt that hyperbolic meteors, except in cases of perturbations by other bodies in the solar system, are extremely rare or possibly non-existent.

¹ *Mon. Not. Roy. Astro. Soc.*, 118, 4 (1958).

² *Nature*, 169, 903 (1952); 170, 878 (1953); 172, 751 (1953).

³ *Mon. Not. Roy. Astro. Soc.*, 104, 257 (1944).

⁴ *Astrophys. J.*, 118, 225 (1951).

EXPERIMENTAL DEMONSTRATIONS OF BALANCE IN POPULATIONS

By DR. A. J. NICHOLSON

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THE accompanying graph records the population changes which took place in a culture of *Lucilia cuprina* Wied. held constantly at 25° C. and provided with ground liver for the adults at the constant rate of 0.5 gm. per day. The other consumable requisites, namely, meat for the larvae (from which the adults were excluded) and water and sugar for the adults, were provided in excess each day. As adults live at least as long when supplied with adequate water and sugar as they do when given protein food also, and as protein food is necessary for egg production,

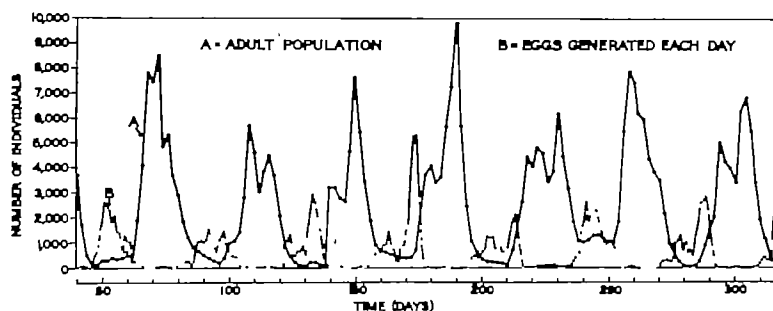
the population was automatically regulated by the effects produced upon egg production by adult competition for the restricted supply of ground liver.

The graph clearly shows an inverse relation between the numbers of adults and the numbers of eggs laid. When the adult population was large, competition for the limited supply of ground liver was so severe that few, if any, adults obtained sufficient for egg production, whereas when the population was small, many obtained adequate supplies and so laid eggs freely. The bimodal form of the egg-generation curves was due to the fact that the population consisted of senile individuals as it approached a minimum, and dominantly of young and vigorous individuals immediately afterwards.

Thus low populations induced the rapid generation of new individuals, whereas high populations suppressed reproduction and so dwindled, with little or no replacement of the individuals that died. Such corrective reaction would have counteracted any departure from the equilibrium density (at which eggs are produced at just the replacement-rate) had there not been a lag of about two weeks between the deposition of eggs and the emergence of the resulting adult flies. This lag between the initiation and operation of reaction produced a violent and sustained oscillation in the population about its equilibrium density, the mechanism being essentially similar to that already described¹ for populations of *L. cuprina* competing for larval food. Although the oscillations resulted from the great disparity existing between the number of births and the number of deaths at almost all times, examination of the data showed that, on the average over a number of complete oscillations, these numbers were virtually equal. It is clear, therefore, that density-induced reaction held the population in a state of balance in its environment.

'Balance' as here used may be defined as a sustained state of corrective reaction to disturbing forces which ensures the persistence of the system. This is normal usage, for it is precisely what we mean when we speak of the balance of a tight-rope walker, or of the balancing of a billiard cue vertically upon a responsive finger-tip. Although 'equilibrium' is one of the senses in which the word is sometimes used, there is no justification for restricting 'balance' to this particular meaning when it is used in relation to population problems, as some biologists do (for example, Solomon²).

Further experiments showed that density-induced compensatory reaction may ensure the continued existence of populations even when subject to great external stresses. The first item in the accompanying table refers to the same culture as the figure, and



	Imposed destruction of emerging adults (per cent)	Mean number of eggs laid per day	Mean number of adults emerged per day	Mean adult population
Adult competition	0	624	573	2,520
	50	732	712	2,335
	75	948	878	1,588
	90	1,361	1,260	878
Larval competition	0	8,794	157	1,252
	75	4,151	192	464
	95	1,921	437	240
	99	1,320	900	128

the next three refer to cultures similar in all respects except that a constant percentage of all emerging adults was destroyed in each. The last four items in the table refer to an otherwise similar group of cultures in which the populations were limited by the provision of only 50 gm. of meat for the larvae in each culture each day. The adults were supplied with excess ground liver, and so could lay eggs freely at all times. In essentials the culture referred to in the fifth item was similar to one previously illustrated¹, and its population oscillated in density with similar violence. All these cultures maintained a state of balance with their environments. Their population patterns were similar to that in the figure, except that the violence of the sustained oscillations decreased with increasing percentages of destruction.

In the first group of cultures the destruction of emerging adults reduced competition, and so permitted a greater number of the surviving individuals to obtain sufficient ground liver to lay eggs; and in the second group the smaller number of eggs laid by the reduced adult population permitted a greater number of the competing larvae to obtain sufficient meat to mature. Consequently in both groups density-governed reaction to increased destruction caused more individuals to emerge on the average each day, as is shown in the table. This in turn caused the reduction of the adult population to be markedly less than the degree of destruction imposed.

In experiments in which other life-stages of *L. cuprina* were destroyed, the same tendency for the immediate effects of destruction to be counteracted by compensatory reaction was observed. Invariably reaction caused more individuals to reach the stage subject to destruction, which in turn caused the densities of some life-stages of the insects to be increased, and those of other stages to be decreased. In general character these results parallel the conclusions reached theoretically in earlier investigations^{2,4} concerning the effects produced by a new destructive factor upon a host population which is governed by the reaction of a specific parasite.

These and other experiments are discussed in greater detail in two articles⁵ which will be published shortly. In one of these it is shown that compensatory reaction to density change is a feature of all kinds of stable population systems, and that it is dominantly responsible for the regulation of populations of all kinds of animals. It is also shown that compensatory reaction is a necessary counterpart of natural selection. Selection by itself merely favours the preservation of the fitter individuals; but, compensatory reaction automatically performs the necessary evolutionary function of eliminating the less-fit individuals, even though these may be so well adapted

that their kind would have persisted indefinitely had the fitter individuals not been present. General arguments leading to this conclusion were given in earlier articles^{2,4}; but the experiments with *L. cuprina* demonstrate the actual existence of the mechanism there postulated.

¹ Nicholson, A. J., *Nature*, **165**, 476 (1950).

² Solomon, M. H., *J. Animal Ecology*, **18**, 1 (1949).

³ Nicholson, A. J., *J. Animal Ecology*, Supp. to 2, No. 1, 122 (1953).

⁴ Nicholson, A. J., and Bailey, V. A., *Proc. Roy. Soc. London*, 561 (1955).

⁵ Nicholson, A. J., *Aust. J. Zool.*, **2**, No. 1 (in the press).

⁶ Nicholson, A. J., *Aust. Zoologist*, **5**, 10 (1957).

MECHANISM OF ANIONOTROPY*

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THREE principal mechanisms, which may be labelled unimolecular, bimolecular and intramolecular, have been considered for anionotropic changes¹. Allylic systems, in particular, have received much attention, and although the existence of all three mechanisms now appears to be conceded by most workers in this field, opinions differ in regard to the extent of their incidence.

The unimolecular ionization theory of anionotropy^{2,3}, which postulates reversible dissociation to give 'kinetically free' anions and carbonium-ions and represents the forerunner of the more general hypothesis of unimolecular nucleophilic substitution, was originally based on the results obtained by Burton⁴ in a study of the rearrangement of 1-phenylallyl-*p*-nitrobenzoate (I) to cinnamyl *p*-nitrobenzoate (II). In view of the strong electron-attracting properties of the carbonyl and nitro-groups, a *p*-nitrobenzoate ester certainly represents a relatively favourable case for the occurrence of mechanism (1).

We have re-investigated this reaction in both aqueous and non-aqueous solvents, following the isomerization by the spectrokinetic technique (in ethanol, (I) shows λ_{max} 2565 Å., ϵ 13,800, whereas (II) shows λ_{max} 2535 Å., ϵ 30,700). It soon became apparent that in non-aqueous solvents—for example, in chlorobenzene at 130°—the 'spontaneous' rate of rearrangement was greatly dependant on the method of purification of the ester and of the solvent, and that the reaction is accompanied by the formation of small amounts of *p*-nitrobenzoic acid which could be extracted with water and estimated titrimetrically with ammonia or polarographically, using a platinum microelectrode (Fig. 1). The production of *p*-nitrobenzoic acid had been previously noticed by Meisenheimer⁵, who also reported that the addition of acid had little effect on the reaction. We find, on the contrary, that the rearrangement is greatly accelerated by *p*-nitrobenzoic acid, and that its rate is very nearly proportional to the concentration of acid above c. 0.01 *M* (Fig. 2, curve 1). At extremely low concentrations of acid, however, the first-order rate constants approach a small, limiting value indicating a residual, non-catalytic rate, which is much smaller than that recorded qualitatively by Burton⁴. This

* Substance of a paper read at a symposium on "Molecular Rearrangements in Organic Chemistry", held at Queen Mary College, London, on April 6.

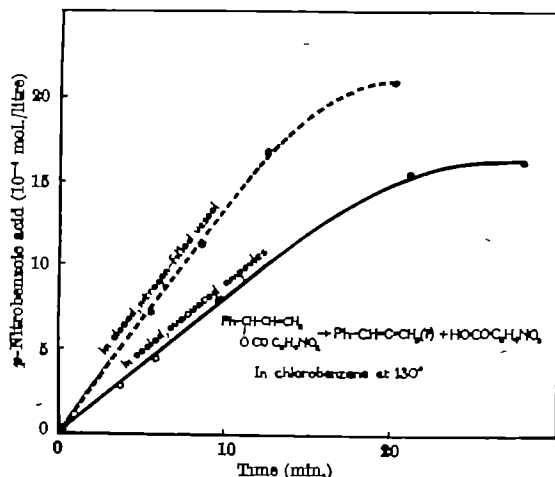
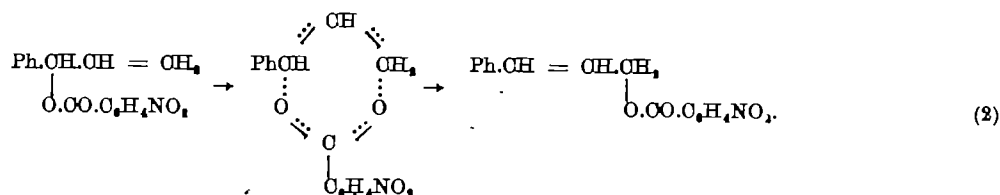
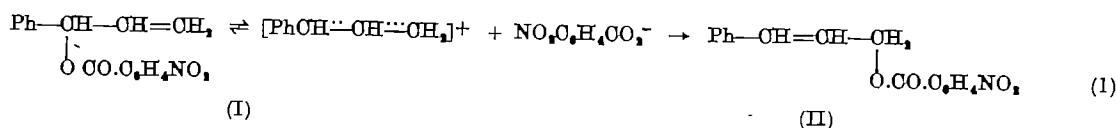


Fig. 1. Elimination of *p*-nitrobenzoic acid from 1-phenylallyl *p*-nitrobenzoate (0.18 M) in chlorobenzene at 130°. In sealed 'Pyrex' glass ampoules (—) and in an unsealed vessel under nitrogen (---).

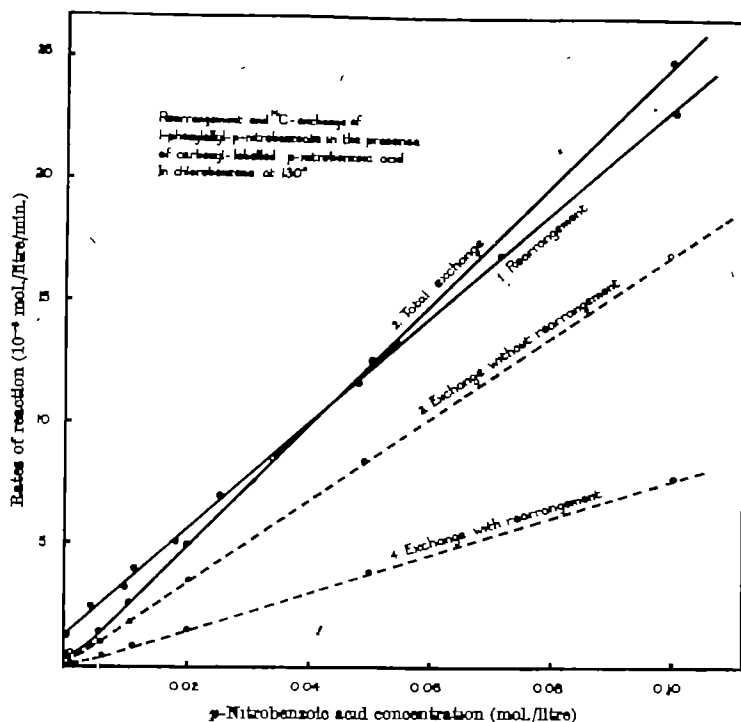


Fig. 2

part of the curve can only be reached by working under rigorously controlled conditions, with complete exclusion of moisture and acidic impurities. Under these conditions, the first-order rate constants exhibit an upward drift as the reaction proceeds, evidently due to the catalytic effect of the *p*-nitrobenzoic acid produced in the side-reaction. The degree of preference for the catalytic mode of rearrangement is indicated by the fact that its specific rate constant in the presence of *p*-nitrobenzoic acid is greater by a factor of about 100 than that of the uncatalysed rearrangement.

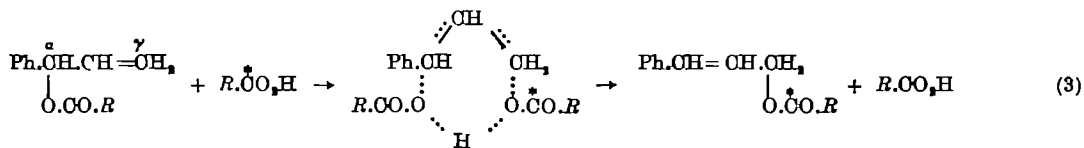
We believe that these experiments constitute the first demonstration of truly thermal rearrangement of an allylic ester in solution. (We have never held the view, ascribed to us by Ingold⁴ and Hughes⁵, that allylic esters will rearrange only in the presence of acids. Our contention, here confirmed, has been that uncatalysed rearrangement is difficult to observe because it is usually swamped by much more facile catalytic processes; see ref. 7.) If the uncatalysed reaction proceeded by mechanism (1), the intermediate carbonium-ions could recombine with partners other than the original *p*-nitrobenzoate ions,

that is, the isomerization would be intermolecular. The simplest alternative is intramolecular rearrangement, as represented in (2).

We have studied the rearrangement in the presence of ¹⁴C-carboxyl-labelled *p*-nitrobenzoic acid as a source of *p*-nitrobenzoate ions. (The acid was prepared by the interaction of *p*-bromonitrobenzene and K¹⁴CN in dry pyridine to give *p*-cyanonitrobenzene, followed by hydrolysis.) The fate of the labelled *p*-nitrobenzoyl group was determined by separating the acid and the two esters at various stages and measuring their specific radioactivity in dimethylformamide solution, using a methane-flow proportional counter. The most significant result is that, at low acid concentrations, the rate of exchange is much less than the rate of rearrangement. This indicates that the uncatalysed, 'spontaneous' rearrangement is intramolecular. Intramolecular anionotropic rearrangement has previously been demonstrated in structurally and environmentally less favourable systems⁷⁻⁹, and it would indeed be most surprising if any other reaction path were followed in the present instance. Why should

a molecule undergo the drastic, energy-consuming step of complete ionization, when it can redistribute its electrons by an internal, synchronized process involving a six-membered cyclic transition state? So far as this particular case, at least, is concerned, the unimolecular ionization theory must surely now be abandoned.

At higher *p*-nitrobenzoic acid concentrations the total rate of exchange rapidly increases (Fig. 2). The larger part of the exchange reaction takes place without rearrangement and must be due to bimolecular substitution by *p*-nitrobenzoic acid or *p*-nitrobenzoate ion at the α -carbon atom. This is analogous to neutral or alkaline hydrolysis in aqueous media, which also proceeds without rearrangement, contrary to the findings of Kanyon, Partridge and Phillips⁸. The smaller part of the exchange reaction takes place with rearrangement, and the difference between curves 1 and 4 (Fig. 2) represents the contribution of the intramolecular isomerization. The acid-catalysed, intermolecular rearrangement which is represented by curve 4 is evidently bimolecular and may proceed by direct attack of undissociated acid molecules at the ethylenic γ -carbon atom of the ester, through a cyclic transition state involving a hydrogen bridge ($R=p\text{-NO}_2\text{C}_6\text{H}_4$):



Alternatively, proton-transfer to the ester to give the oxonium-ion, in which the existing alkyl-oxygen bond is weakened, may precede bimolecular attack, as in aqueous solvents¹. We cannot yet distinguish between these two versions, partly because nothing is known about the ionization equilibria of *p*-nitrobenzoic acid in chlorobenzene, and further investigations, including acidity-function measurements, are in progress.

The non-participation of 'foreign' anions in the rearrangement of 1-phenylallyl *p*-nitrobenzoate is easily shown in the case of bromide ions by the fact that no cinnamyl bromide is formed when the reaction is carried out in the presence of diisobutylammonium bromide. Burton³ sought to demonstrate the participation of acetate ions by heating 1-phenylallyl *p*-nitrobenzoate with acetic anhydride and tetramethylammonium acetate and isolating cinnamyl acetate. However, since reagent-grade acetic anhydride contains acetic acid, and since the two known procedures for the preparation of tetramethylammonium acetate give products which contain acetic acid or water of crystallization¹⁰, there is little doubt that in Burton's experiments the rearrangement was taking place in the presence of acetic acid. Burton states, without details, that 1-phenylallyl *p*-nitrobenzoate could be "left for some months without change in solution in acetic acid, acetic acid containing a few drops of 30% hydrobromic acid and alcoholic hydrochloric acid", but we have found that rearrangement takes place quite rapidly under such conditions. Viewed in this light, Burton's experiments no longer provide evidence for the participation of acetate anions, and, without dogmatizing before further investigation as to what happens in

the solvent acetic anhydride, the result obtained with tetramethylammonium acetate can be interpreted as due to bimolecular γ -substitution by acetic acid, analogous to the intermolecular rearrangement which occurs in chlorobenzene in the presence of *p*-nitrobenzoic acid.

The present results thus support the view^{1,7,11,12} that the rearrangement of allylic alcohols and esters is normally bimolecular, or, in special cases, intramolecular. Bimolecular, non-isomeric rearrangement has also been demonstrated by Kepner, Winstein and Young¹³, and others^{14,15}, in allylic halides. Ingold and his associates^{1,5} have adduced reasons why bimolecular rearrangement (which they term S_N2') should be rare. One of us¹ has pointed out, however, that although bimolecular attack by charged anions at the ethylenic γ -carbon atom will be impeded by the electrostatic repulsion due to the unsaturation electrons, attack by neutral molecules (for example, H_2O , ROH , RCO_2H , NR_3 , etc.) will be far less subject to such an effect. It should also be remembered that intramolecular and bimolecular mechanisms (for example, equations 2 and 3) on one hand, and unimolecular mechanisms (for example, equation 1) on the other, represent extremes of a continuous range of possible time-sequences. It is quite conceivable that in mechanism (2), for example,

the intermediate stage possesses some ion-pair character. Similarly, in mechanism (3), bond-breaking at C_α may be slightly ahead of bond-making at C_γ ; this will leave the whole process essentially synchronized, and the electron displacements will be assisted by the unshared electron pair on the oxygen atom being joined to C_γ . Such a concept is entirely analogous to that of 'hybrid' mechanisms in nucleophilic substitution¹⁶⁻¹⁸.

We are much indebted to Prof. R. P. Linstead for providing us with the facilities for work with radioactive tracers. We also thank the Department of Scientific and Industrial Research for a maintenance grant to one of us (E. S. W.) during 1948-50.

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LETTERS TO THE EDITORS

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An Unusual Virus Disease of a Dipterous Larva

AN apparent nuclear disease of the larva of the crane fly, *Tipula paludosa*, was briefly described in 1923 by Rennie¹. We have now rediscovered this disease, which seems to be infectious, and have compared it to some extent with the nuclear and cytoplasmic polyhedroses of lepidopterous larvae, from which it differs in some important respects.

In the nuclear polyhedral diseases of lepidopterous larvae, virus rods arise in the chromatic masses of infected nuclei², and are liberated into the clear nuclear ring zone where the polyhedral protein also accumulates. Crystalline polyhedra form in which the virus rods, c. 300 m μ $\times$ 40 m μ , are embedded. This type of polyhedra becomes surrounded by a membrane. In dilute sodium carbonate the polyhedra swell slightly, and, with few exceptions, dissolve readily, freeing the virus rods contained within.

The cytoplasmic polyhedra of the gut contain spherical virus particles³. In a paper now in the press⁴ we have demonstrated, in the case of the larva of the angle-shade moth, *Phlogophora meticulosa*, the interesting fact that the virus particles are composite in nature. The virus bodies are embedded in a matrix of polyhedral protein and measure about 60 m μ in diameter. Each consists of four or five smaller spheres, approximately 12 m μ in diameter. During the course of the disease the small spheres apparently arise first in the cytoplasm and secondarily associate into the larger bodies prior to the formation of the polyhedra. The minimal infectious unit may well be the small particles of 12 m μ diameter. The cytoplasmic polyhedra also dissolve in weak alkali, but partially and in a different manner from the nuclear type. The larger virus bodies readily dissociate into their small component spheres which, on account of their small size, are easily overlooked.

In the polyhedrosis of *Tipula*, a chromatic mass forms in the enlarged nuclei of the blood cells, and from this mass the chromatic material segregates as several spherical bodies, leaving a large eosinophile body in the nucleus; the polyhedra seem to arise around the periphery and are closely applied to the nuclear membrane (Fig. 1). They differ in appearance and may be rectangular or shaped like a segment of an orange. They are negatively birefringent and appear to be genuine crystals. Their behaviour in the presence of different reagents is most unusual and differentiates them sharply from either of the other groups of polyhedra. They are resistant to trypsin and to dilute and weak acids and alkalis. In 1 N sodium hydroxide they elongate to six or more times their length,



Fig. 1. Blood cells from an infected larva of *Tipula paludosa*, showing the polyhedral crystals. $\times 1,500$

becoming first biconvex spindles and then elongating into crescents or worm-like shapes (Fig. 2). At about three times their normal length this elongation is still completely reversible, and in water, at pH 6-8, they return to their original size and shape. After such treatment, however, the polyhedra are 'activated'; in other words, they now respond in a similar manner in ammonia, 1-12 per cent sodium carbonate and hydrochloric acid, pH 1-4; but not to 1 N hydrochloric acid or 25 per cent sodium carbonate. The elongation and contraction or return to normal shape, which take place along the same axis, can be repeated indefinitely in these solutions and take place as rapidly as the solutions can be alternated.

The polyhedra are not usually dissolved even after half an hour in 1 N sodium hydroxide at 20° C. In a solution of equal parts of 1 N sodium hydroxide and 1 N potassium cyanide, the response is speeded up enormously and the polyhedra elongate even further to reach their maximum in 1½ min. They dissolve completely in 2-4 min. The polyhedra give a positive reaction with xanthoproteic and ninhydrin tests, and stain with bromophenol blue after treatment for 15 min. with 1 N hydrochloric acid at 60° C. Their substance is Feulgen-positive throughout, and each polyhedron has intensely staining granular bands at about ½ μ intervals. Tests for sulphur have been negative.

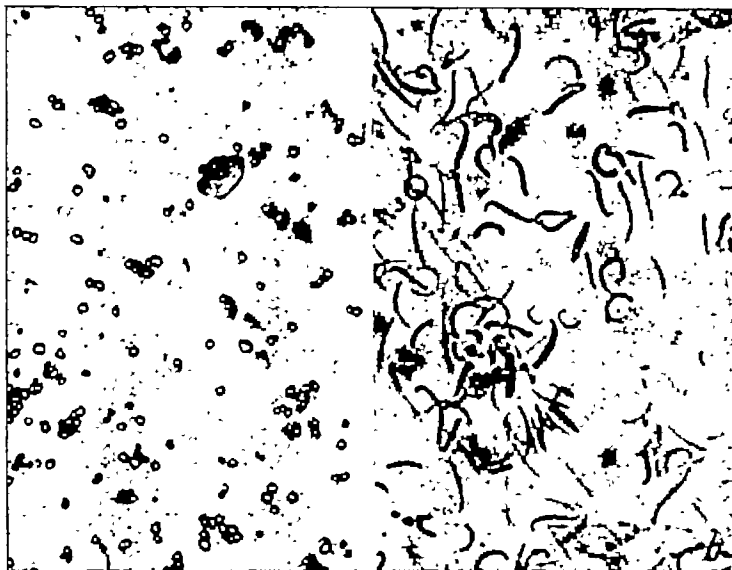


Fig. 2. On left, untreated polyhedra; on right, the same after treatment with 1 N sodium hydroxide and 1 N potassium cyanide for 90 sec. $\times 200$



Fig. 8. 'Ghost' of a polyhedral crystal after treatment for 4 min. with 1 *N* sodium hydroxide, 1 min. 0.5 *N* sodium thiolglycollate (pH 8.4) and 1 min. 1 *N* sodium hydroxide. Note the apparent virus rods $\times 14,700$

In such resistant polyhedra as these, it is a difficult matter to observe any possible virus bodies within. However, we have made studies, on the electron microscope, of polyhedra subjected to various treatments. In one, the polyhedra were exposed to 1 *N* sodium hydroxide and washed. The resulting elongated forms appeared semi-opaque with a granular and fibrous structure. In another series the polyhedra were treated with 1 *N* sodium hydroxide for 4 min., then washed and treated with sodium thiolglycollate at pH 8.4 for 4 min., and finally washed and treated for one minute with 1 *N* sodium hydroxide. Under this treatment, most of the substance of the polyhedral crystal is dissolved, leaving behind a lens-shaped 'ghost'. In many polyhedra treated in this fashion we have observed rod-shaped bodies which could be virus rods (Fig. 3).

Acknowledgments are due to Mr. H. C. F. Newton and Miss Margaret Megaw, of the National Agricultural Advisory Service at Wolverhampton, who sent us the batch of larvae in which the first diseased specimen was found, to Dr. Max Perutz for his determination of the negative birefringence of the crystals, and to Miss Elizabeth Green, of the Cavendish Laboratory, who took the electron micrograph.

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Form of Myelinated Nerve Fibres

D'ARCY THOMPSON¹ directed attention to the fact that the shape of a liquid body may be regarded as a 'diagram of forces' acting on it at the moment. As the myelinated nerve fibre is a liquid thread enclosed in a distensible and elastic² neurilemmal tube, it was thought that a thorough determination of its shape might help to reveal some of the forces maintaining the structure and organization of the fibre.

It is essential for the determination of the shape to make measurements on living fibres in which the physical state of axoplasm and myelin remains unaltered and the proportions of different regions are as undistorted as possible. Carefully teased preparations of unstained fibres were used for this purpose. When the teased fibres are allowed to float freely in a chamber some 100–200 μ deep instead of being simply spread out between slide and coverslip, their deterioration is greatly delayed and the shape of the fibres remains unchanged for many hours. The dimensions observed in such conditions presumably do not deviate markedly from those of the fibres in normal physiological surroundings.

The nerve fibre, which is approximately cylindrical along the internodes, presents, as was noticed by Ranvier³, small bulbous enlargements on both sides of the nodes. These enlargements are not symmetrical. One of them is always more bulky and longer than the other⁴ (Fig. 1). In marking the original direction of the nerve at the removal from the body, it was found that the larger bulb is always situated on the proximal side of the node in mixed as well as in purely sensory nerves.

In order to test whether the asymmetry of the bulbs is not an artefact due to the direction of teasing, the nerves were teased in opposite directions

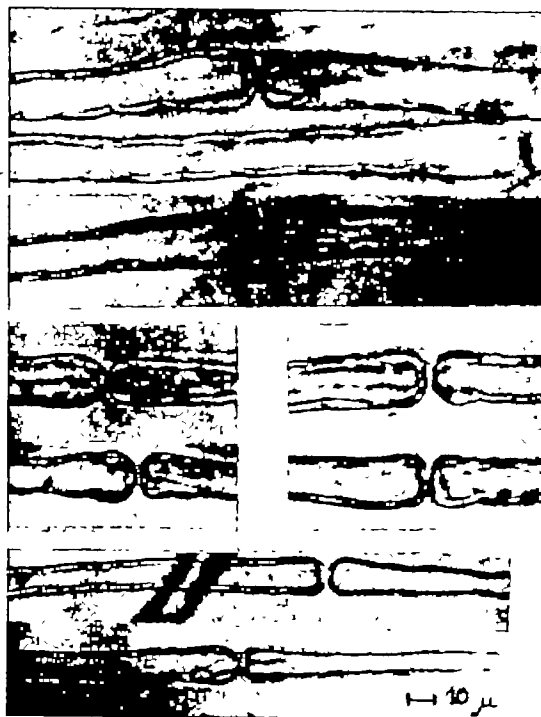


Fig. 1. Photomicrographs of nodes of Ranvier in cat peripheral nerve fibres. Proximal bulbs on the left.

Table 1. MEAN VALUES AND CONFIDENCE LIMITS (t-TEST) AT 5 PER CENT LEVEL OF PROBABILITY OF SEVERAL DIMENSIONS OF THE JUXTANODAL REGION IN CAT NERVE FIBRES (IN MICRONS)

Mean inter-nodal diam. A	Maximal diam. of bulbe		Diam. of bulbe at a distance of one internodal width from the maximal diam.		Distance between node and max. diam. of bulb		Diam. of node C	No. of nodes
	Proximal P_1	Distal D_1	Proximal P_2	Distal D_2	Proximal P_3	Distal D_3		
6.2	8.35 $\pm$ 0.30	7.83 $\pm$ 0.23	7.25 $\pm$ 0.23	6.83 $\pm$ 0.15	7.56 $\pm$ 0.39	7.15 $\pm$ 0.60	4.37 $\pm$ 0.18	61
8.0	11.24 $\pm$ 0.30	10.53 $\pm$ 0.32	9.53 $\pm$ 0.30	9.18 $\pm$ 0.27	8.19 $\pm$ 0.46	7.56 $\pm$ 0.50	5.33 $\pm$ 0.25	60
10.0	13.65 $\pm$ 0.31	12.54 $\pm$ 0.36	12.07 $\pm$ 0.28	10.63 $\pm$ 0.24	9.61 $\pm$ 0.78	7.76 $\pm$ 0.55	6.79 $\pm$ 0.31	65
12.0	15.90 $\pm$ 0.30	14.80 $\pm$ 0.37	14.20 $\pm$ 0.28	12.98 $\pm$ 0.27	10.52 $\pm$ 0.62	8.90 $\pm$ 0.73	7.53 $\pm$ 0.27	57
14.0	18.23 $\pm$ 0.31	16.90 $\pm$ 0.39	16.23 $\pm$ 0.30	14.83 $\pm$ 0.30	11.35 $\pm$ 0.56	9.53 $\pm$ 0.63	8.43 $\pm$ 0.29	58
16.0	20.06 $\pm$ 0.34	18.68 $\pm$ 0.39	17.86 $\pm$ 0.31	16.39 $\pm$ 0.27	12.09 $\pm$ 1.02	10.06 $\pm$ 0.63	8.65 $\pm$ 0.34	51
17.6	21.51 $\pm$ 0.26	20.30 $\pm$ 0.40	19.31 $\pm$ 0.41	17.87 $\pm$ 0.25	12.70 $\pm$ 1.23	9.48 $\pm$ 0.89	9.75 $\pm$ 0.38	28
19.5	23.91 $\pm$ 0.38	22.58 $\pm$ 0.33	21.54 $\pm$ 0.31	20.01 $\pm$ 0.37	13.47 $\pm$ 1.62	10.46 $\pm$ 0.85	9.77 $\pm$ 0.53	40

in two sets of experiments. No influence of the direction of teasing could be detected during examination of some six hundred nodes. A bulb situated centrally was larger in fibres teased in both directions.

The inequality of juxtanodal bulbe was observed in peripheral fibres of mice, rats, guinea pigs, rabbits, cats, dogs and frogs. The general occurrence of this phenomenon suggests that the polarity of the bulbe may be a reflexion of some fundamental process going on in all myelinated nerve fibres and merits a closer quantitative analysis. This was carried out on fibres from cat peripheral nerves. The dimensions chosen to determine the shape of the juxtanodal region of the fibre, and allowing for calculation of volumes, are shown in Fig. 2. The mean diameter of the fibre was determined from six measurements taken along the internodes adjacent to the nodal region examined. The results of measurements of more than four hundred nodes were grouped by internodal diameter classes, and mean values and con-

fidence limits of each dimension are presented in Table 1.

It will be seen that the diameters of the proximal bulbe are consistently larger than the corresponding diameters of the distal bulbe. The scatter of longitudinal dimensions is larger than that of diameters, and the difference between P_1 and D_1 is not significant for smaller fibre groups. The calculation of bulbar volumes based on these data reveals a net surplus of material in the proximal bulbe, amounting to 100–2,000 μ^3 , according to the fibre size.

Fig. 2 shows the relative width of characteristic parts of the nodal region as a percentage of the mean diameter of the internode in fibres ranging from 5 to 20 μ in diameter. It was shown previously on rabbit nerves that the neurilemmal tube, relatively inextensible in the nodes, is distensible and elastic over the internodes, and is actually distended by the fibre contents. The normal width of the fibres is determined by an equilibrium between the turgor pressure of the axoplasm and the elastic tension of the neurilemma. In order to evaluate the normal degree of distension of the internodal neurilemma in cat fibres, the excess of material was removed from a limited portion of the fibres by local application of external pressure. Under a gradually increasing external pressure, the fibres in the compressed part contract progressively but preserve their cylindrical outline. When the external pressure exceeds a certain critical value, the fibres become flattened and entirely emptied of their contents. By keeping the external pressure just below the critical value, the 'unstretched' diameter of the nerve tube is obtained. It was measured in 265 fibres and the results, grouped by normal fibre size and calculated as a percentage of the mean normal diameter of the internode, form the lowest curve in Fig. 2. It will be noted that the unstretched diameter amounts to about 40 per cent of the normal diameter in fibres of all sizes. This means that the internodal portions of neurilemmal tubes are distended by the pressure of axoplasm in the same proportions in all fibres. The degree of distension of the bulbar region depends on the diameter of the fibres and decreases with increasing diameter except for the smallest and the largest fibre groups.

Although a full interpretation of the form of the fibres requires further experiments, their morphological polarity seems to provide an additional confirmation of the existence of a proximo-distal flow of axoplasm in the axon. The nodal part of the nerve tube, narrower and less extensible than its internodal portion, creates a resistance to the flow and leads to piling up of material above the node. The situation resembles closely that created artificially by Weiss⁸ in experiments with apposition of a con-

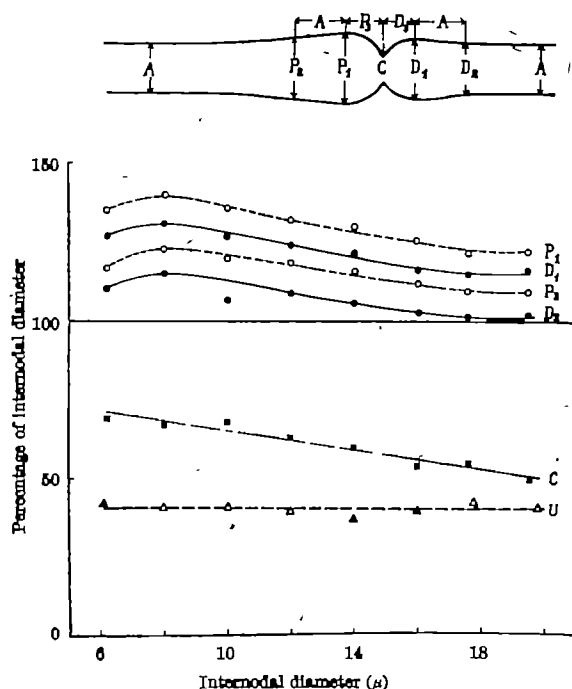


Fig. 2. Relative dimensions in the nodal region of cat peripheral nerves as a percentage of the mean diameter of the internode. The diagram indicates which dimension each of the upper curves refers to: A , mean diameter of the internode; U , unstretched diameter of the neurilemmal tube; P_1 , proximal bulb; D_1 , distal bulb; C , diameter of the node.

stricting sleeve on the nerve. The morphological result is also similar in both cases.

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Observations on Experimental Anthrax: Demonstration of a Specific Lethal Factor produced *In vivo* by *Bacillus anthracis*

AN ENIGMA in the study of the cause of death in anthrax has been that no lethal endo- or exo-toxin has been found in cultures of the organism¹⁻³. Recently, we have been able to demonstrate a factor in the plasma of guinea pigs dying of anthrax which is not only lethal but also specifically neutralized by anthrax antiserum. This communication describes briefly work which has led to this finding. A fuller report will be published elsewhere.

In previous studies⁴⁻⁶, a mixture of the plasma (approximately 1 part) and peritoneal and thoracic exudates (approximately 5 parts) was collected from guinea pigs dying of anthrax for studies of the chemical basis of the virulence of *B. anthracis*. It was shown that large volumes of this plasma-exudate and extracts of the organisms separated from it were non-lethal to guinea pigs when injected intraperitoneally. The conclusion was reached that the products of *B. anthracis* growing *in vivo* were not markedly toxic. This agreed with the fact that large numbers (approximately 1×10^8 chains per ml.) grew in the blood of a guinea pig before death resulted. It was suggested that death followed the action of harmful effects which were weak, relative to the number of organisms producing them. One such effect was the slight tissue-damaging activity shown in this and previous work⁷.

Attention then turned to the significance of the massive terminal bacteraemia in the death of normal guinea pigs. This topic was important in view of reports^{8,10} that some animals of other species die of anthrax without a marked bacteraemia. Guinea pigs (700 gm.) were infected intradermally with *B.*

anthracis (strain N.P.). On the third day, and in the twelve hours preceding death, the number of organisms in the blood rose from $0.2-0.4 \times 10^8$ to $0.5-1.0 \times 10^8$ chains per ml. There was a remarkably constant relationship between the bacterial count of the blood and the interval before the host's death. The administration of streptomycin abruptly terminated the bacteraemia, and provided the latter had not increased beyond 3×10^6 per ml., the animals were saved (20/23 with $0.7-1.5 \times 10^6$ per ml. of blood). All guinea pigs having a bacteraemia greater than the critical level (47/47 with $0.7-1.5 \times 10^7$ per ml.) died 1-3 days later, although free from active infection. These experiments showed conclusively that a bacteraemia appeared to be an essential factor for death, but the fate of the guinea pig was determined when the blood-stream invasion had reached only 1/300 of its maximum. This finding almost certainly renders untenable the views that death from anthrax might be due to mechanical blockage by the organisms or to a deficiency in the host of oxygen, etc.

An insight into the probable nature of the lethal product of *B. anthracis* was provided by chemical examination of the blood, histological examinations and clinical observations on guinea pigs at their death, both from active infection and later, after this had been removed by streptomycin. A raised haematocrit and total blood nitrogen, lowered plasma protein, the presence of anuria, delayed clotting of blood, terminal collapse with subnormal temperatures $85^\circ-89^\circ$ F. and histological and chemical evidence of acute nephrosis were noted. These observations and others as yet incomplete provided sufficient evidence for a working hypothesis that the animals died 'in shock'¹¹. This agrees with the known oedematous and haemorrhagic nature of anthrax and with the fact that guinea pigs, which die two to three days after the bacteraemia has been stopped by streptomycin, have acute renal failure (plasma constituents were: protein nitrogen, 373; non-protein nitrogen, 179; urea, 311; phosphorus as inorganic phosphate, 18; and calcium, 7.5 mgm. per 100 ml.; presence of anuria and severe nephrosis).

This evidence emphasized the importance of an oedema-producing factor. We therefore re-examined the distribution and activity of the tissue-damaging factor. Filtered heparinized plasma from guinea pigs dying of anthrax (strain N.P.) was much stronger in this respect than the plasma-exudate formerly used⁶. Plasma (0.2 ml.), when injected intradermally into test guinea pigs, produced an extensive area of oedema and congestion (40 mm.), and a positive reaction still resulted from a dilution of 1/25 of the material.

Table 1. SPECIFIC LETHAL EFFECT OF PLASMA FROM GUINEA PIGS DYING OF ANTHRAX

Anthrax plasma injected (vol. in ml.)	Mice (18-22 gm.) (Figures show the number of deaths in batches of 5 mice)												Guinea pigs (250 gm.) (number dead) (number treated)			
	Intravenously						Intraperitoneally						Intravenously		Intra- peritoneally	
	1 0	1 0	0.5	0.5	0.25	0.25	1 0	1 0	0.5	0.5	0.25	0.25	6	6	8	6
		+ a.s.*		+ a.s.		+ a.s.		+ a.s.		+ a.s.		+ a.s.		+ a.s.		
Batch 1	5	—	4	—	—	—	5	—	2	—	—	—	—	—	—	—
Batch 2	5	0	3	0	2	0	5	0	2	0	1	0	2/2	0/3	1/4	—
Batch 3	5	0	5	0	2	0	4	0	5	0	0	0	5/6	0/5	1/3	1/2
Batch 4	5	0	4	0	2	0	2	0	1	0	0	0	3/4	0/4	—	3/7
Total deaths %	100	Nil	80	Nil	40	Nil	73	Nil	53	Nil	7	Nil	53	Nil	28	44

* a.s. means that anti-anthrax horse serum (half to a third the volume of the plasma) was allowed to react with the anthrax guinea pig plasma at room temperature before injection.

Volumes of 1 ml. or greater were injected into mice in 0.5-ml. aliquots at several hour intervals.

Guinea pigs were injected into the jugular vein using a local anesthetic.

Adequate control groups of mice and guinea pigs were injected with appropriate volumes of normal guinea pig plasma with the addition of lysed red cells (equivalent to the 10-15 per cent haemolysis usual in the plasma of guinea pigs dying of anthrax). No deaths occurred.

Tests on samples of plasma taken at intervals during the bacteremia showed that this tissue-damaging activity increased regularly with the increase in the numbers of organisms in the blood. Anthrax antiserum (horse; Weybridge spore vaccine; produced by our colleague, F. C. Belton) neutralized the skin reaction completely. When the peritoneal exudate was found to be low in tissue-damaging activity, an explanation was revealed for the relatively low activity of the mixture of plasma and exudate previously used. This had consisted largely of exudate.

The possibility of a specific lethal effect of the undiluted plasma was now investigated. Table 1 summarizes the results of four experiments with mice and guinea pigs injected intravenously and intraperitoneally with the plasma. The resulting deaths, coupled with the absence of deaths in control animals and in those receiving plasma mixed with the anthrax antiserum, shows clearly the lethal nature and specific character of the factor present in such plasma. A higher death-rate and a shorter survival-time indicated that the plasma was more effective intravenously than by the intraperitoneal route which had been used in previous studies⁶. Finally, animals dying in these experiments showed the same symptoms of oedema, collapse with subnormal temperatures, and of nephrosis as did infected animals.

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Phosphate Partition and Turnover in Human Red Cells

PHOSPHATE partition and turnover in the human red cell can be studied by paper chromatography, which permits unequivocal separation of the organic phosphate compounds involved in carbohydrate metabolism.

In the following experiments, 20 ml. of heparinized whole blood was incubated at 37° C. with about

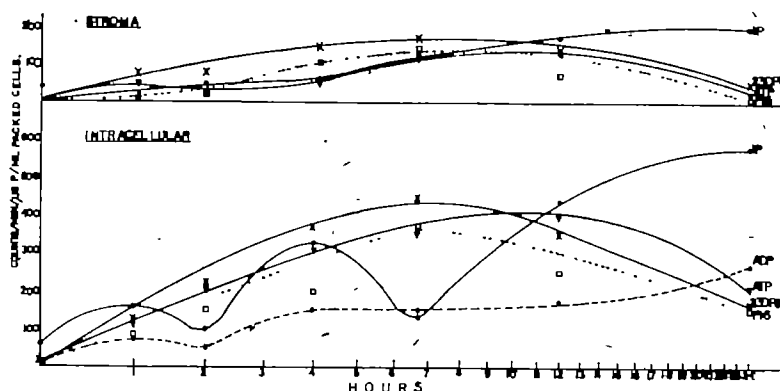


Fig. 1. Relative specific activity (counts/min./μgm. phosphorus/ml. packed cells) against time. Key to curves: IP, inorganic phosphorus; 2,3-DPG, 2,3-diphosphoglycerate; ATP, adenosine triphosphate; F16, fructose-1,6-diphosphate; ADP, adenosine diphosphate.

50 μc. of sodium dihydrogen phosphate (³²P) and samples removed after varying times, the whole system being kept mixed and at constant pH by the introduction of 95 per cent oxygen, 5 per cent carbon dioxide. The red cell samples were packed by centrifuging and washed twice with an isotonic phosphate buffer of pH 7.4 after removal of the buffy coat. All centrifuging was carried out at 2,500 g for 15 min. The cells were then hemolysed with water and saponin, and the stroma separated by high-speed centrifuging after buffering the solution to pH 4.2 with an acetate buffer¹. After removal of the supernatant fluid, the stromal fraction was further washed twice with the buffer. Trichloroacetic acid extracts could then be made from both the stroma and intracellular contents of the cells and treated chromatographically in the manner described by Caldwell². Location of individual spots was carried out with a scanning counter, and these were cut out and their radioactivities assayed by conventional methods. The total phosphorus in each spot was estimated by the method of Berenblum and Chain³.

In this way, relative specific activities of the following compounds can be plotted against time: adenosine triphosphate, adenosine diphosphate, fructose-1,6-diphosphate, 2,3-diphosphoglycerate, and inorganic phosphorus. With normal cells the curves shown in Fig. 1 are given.

It is obvious that a pool of glycolysis exists in the stroma separate from that in the intracellular fraction, since their activities do not show a parallel change. Also, in the intracellular fraction, 2,3-diphosphoglycerate shows a precursor relationship with adenosine triphosphate. This relationship is opposite to the findings of Gourley⁴, who used methods involving partial hydrolysis of cell extracts to characterize each intermediate compound. Our findings would necessitate the operation of Rapoport's mutase⁵ and the coenzyme action of 2,3-diphosphoglycerate in the conversion of 3-phosphoglycerate to 2-phosphoglycerate⁶. Since the phosphorus atom attached to the first carbon atom of 1,3-diphosphoglycerate is transferred to adenosine diphosphate by the 1,3-diphosphoglycerate phosphokinase⁷, it is reasonable that 2,3-diphosphoglycerate, which is in equilibrium with the latter, should show a precursor relationship to adenosine triphosphate. These relationships will be discussed more fully at a later date when further observations will be reported.

This technique provides a simple method for studying simultaneously the effects of various substrates on the phosphate compounds of the red cell. For example, adenosine, known to be utilized by red cell hemolysates⁶, can be shown to be differentially metabolized by the stroma and intracellular fractions of normal and certain pathological cells⁶.

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Highly Purified Choline Acetylase

THE enzymatic synthesis of acetylcholine in the mammalian organism is inextricably linked with the general metabolism, especially with the general acetylating reactions. Hence it may be more rational to restrict the term 'choline acetylase' in its application to an enzyme which catalyzes the reaction between choline and 'active acetate' or acetyl-coenzyme A, as shown in the following equation:



According to Balfour and Hebb¹, there are two routes for biological synthesis of acetylcholine in mammalian tissues, namely, the acetate- and the citrate-utilizing system respectively.

Quite independently of Balfour's studies, we have already reported² a similar observation on a system synthesizing acetylcholine, in which emphasis was laid on the difference in the distribution as well as localization of both systems in mammalian tissues. Characteristically enough, the citrate system was found to be present abundantly only in nervous tissues, in contrast with the overall distribution of the acetate system in all tissues yielding acetylcholine. The universality of the acetate system was also demonstrated by the following observations. All the water-soluble extracts of such tissues as those listed in Table 1, which *per se* could scarcely synthesize acetylcholine, were shown to contain an accelerating factor enhancing the enzymatic synthesis of acetylcholine by guinea pig brain extract with acetate. In acetylcholine synthesis with citrate, on the other hand, we could not find any significant amount of such an accelerating factor.

The accelerating factor effective in the acetate system may be identical with the acetate-activating

Table 1. ACCELERATING EFFECT OF SOME TISSUE EXTRACTS ON THE SYNTHESIS OF ACETYLCHOLINE

Tissue	No. of Exp.	Substrate	
		Acetate	Citrate
Dog ventricular muscle	11	166 ± 6 per cent	109 ± 3 per cent
Guinea pig kidney	5	188 ± 11 " "	111 ± 3 " "
Guinea pig ventricular muscle	2	158 ± 8 " "	108 ± 1 " "
Guinea pig liver	2	128 ± 8 " "	111 ± 6 " "
Guinea pig skeletal muscle	1	136 " "	112 " "
<i>Escherichia coli</i>	1*	180 " "	" "
Control		100	100

Control mixture contained 3 μ M adenosine triphosphate, 1.0 unit (for acetate system) or 0.8 unit (for citrate system) coenzyme A, 4 μ M choline, 140 μ M (for acetate system) or none (for citrate system) potassium chloride, 8 μ M (for acetate system) or 5 μ M (for citrate system) magnesium chloride, 15 μ M cysteine, 1 μ M ascorbic acid, 5 μ M sodium fluoride, 8 μ M phosphate, 10 μ M acetate or citrate and dialysed water-soluble extract derived from 10 mgm. of freeze-dried powder of guinea pig brain. In testing mixture, fractionated extract of tissue listed above (30–40 gm./dl. fraction by ammonium sulphate) was added (* extract itself was used). pH 6.8. Final volume 1 ml. Incubated for 60 min. at 37° C. Figures indicate the amount of synthesized acetylcholine in testing mixture, expressed as a percentage of the control sample.

system or adenosine triphosphate-acetate reaction system described by Lipmann³. To verify this assumption, we had to separate choline acetylase from the acetate-activating system; this was accomplished by the following procedure, carried out at 4° C. or lower:

PREPARATION OF CHOLINE ACETYLASE	
1 gm. freeze-dried powder + 10 ml. M/50 phosphate of brain (pH 6.8)	
Residue discarded	← Centrifuged for 20 min. at 1,500 g.
Residue discarded	← Supernatant acidified with acetic acid to pH 4.5 and chilled for 5 hr. or more at 0° C.
	Clear supernatant (see text) neutralized to pH 6.8.
Residue discarded	← Ammonium sulphate added to final concentration of 15 gm./dl.
Supernatant discarded	← Ammonium sulphate added to final concentration of 35 gm./dl.
Residue made up to 1 ml. with M/50 phosphate (pH 6.8) and dialysed against M/50 phosphate (pH 6.8)	
Residue discarded	← Acidified with acetic acid to pH 5.0 and chilled for 30 min. at 0° C.
	Supernatant neutralized to pH 6.8.

The choline acetylase thus prepared had lost almost completely its power to yield acetylcholine. However, when extract of kidney or *Escherichia coli* and other organisms were added, it regained its power to synthesize acetylcholine (Table 2). This implies that we have succeeded in separating choline acetylase almost completely from the acetate-activating enzyme system without losing its activity.

Further evidence was given by the following experiments (Table 3). Choline and 'active' acetate or acetyl-coenzyme A, prepared by the method of Littlefield and Sanadi⁴, yielded acetylcholine under the influence of our choline acetylase without further addition of coenzyme A, adenosine triphosphate and acetate.

Our method of separating choline acetylase is also applicable to fresh brain tissues; but freeze-dried powder of guinea pig brain always gives the most satisfactory results. Under the most appropriate conditions, 1 mgm. of our choline acetylase was

Table 2. SYNTHESIS OF ACETYLCHOLINE BY COUPLING CHOLINE ACETYLASE WITH THE ACETATE-ACTIVATING ENZYME SYSTEM

Example	Preparation	Acetylcholine synthesized ($\mu\text{gm./ml. hr.}$)
1	Complete system Choline acetylase (20 mgm./ml.) Kidney extracts* (15 mgm./ml.)	7.5 < 0.05 < 0.05
2	Complete system Choline acetylase (20 mgm./ml.) Kidney extracts* (15 mgm./ml.)	12.5 0.07 < 0.05
3	Complete system Choline acetylase (20 mgm./ml.) <i>Escherichia coli</i> extracts (40 mgm./ml.)	9.5 < 0.05 < 0.05

Details as in Table 1, except enzyme source. Figures in parentheses indicate the amount of freeze-dried tissue powder used.

* 20–40 gm./dl. fraction of ammonium sulphate was used.

Table 3. SYNTHESIS OF ACETYLCHOLINE FROM CHOLINE AND ACETYL-COENZYME A BY CHOLINE ACETYLASE

	Acetyl-coenzyme A yielded by	Acetylcholine synthesized ($\mu\text{gm./ml.}$)
1	Guinea pig kidney (75 mgm.)	4.25
2	<i>Escherichia coli</i> (45 mgm.)	2.20

Each sample contained 4 μM choline, 8 μM cysteine, 8 μM phosphate and acetyl-coenzyme A. Extract of freeze-dried powder of kidney or *Escherichia coli* was incubated with adenosine triphosphate, coenzyme A, potassium and magnesium ions, cysteine and acetate at 37° C. After 90 min. incubation, the mixture was added to pH 8.5 and heated at 80° C. for 2 min. From this mixture active acetate or acetyl-coenzyme A was prepared by the method of Littlefield *et al.* (ref. 4). Figures in parentheses indicate the weight of the freeze-dried tissue used.

shown to synthesize 0.5 mgm. of acetylcholine an hour when coupled with the acetate-activating enzyme system.

In the course of preparing choline acetylase, it is worth noticing that the supernatant still contained a considerable amount of the citrate-activating system, after the first acidification in the preparation of choline acetylase, though the acetate-activating system had already been excluded almost completely.

Further purification of choline acetylase is now in progress; details of the present experiment will be published elsewhere.

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Evidence for the Occurrence of Glucose Dehydrogenase in Yeast

WHEN buffered suspensions of washed bakers' yeast are incubated anaerobically with methylene blue, dehydrogenase activity as measured by the rate of decolorization is greater with glucose than it is with other substrates. While investigating the action of nicotine on various dehydrogenase systems, including those of yeast, we found that, whereas nicotine inhibited dehydrogenase activity of *Saccharomyces cerevisiae* with glucose, activation resulted with glucose-6-phosphate as substrate.

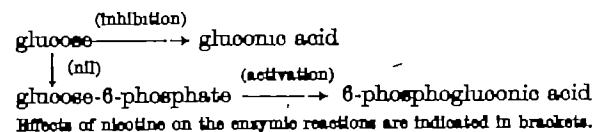
For these experiments we used cells harvested from young—not more than one day old—actively growing cultures. Before preparing the final suspensions in phosphate buffer, they were washed and aerated in suspension for two hours at 37° to reduce the dehydrogenase activity due to endogenous metabolites. Dehydrogenase activities in the presence of added substrate and triphenyltetrazolium bromide were measured at 30° and pH 7.6 by the method of Fahmy and Walsh¹.

For experiments using glucose-6-phosphate as substrate the cell membranes were first ruptured by alternately freezing and thawing, as the substrate was otherwise unable to penetrate the cells. Experiments showed that this procedure, though reducing dehydrogenase activity with glucose, did not influence the effect of nicotine; thereby demonstrating that the inhibitory action of nicotine was not due to its preventing the substrate from entering the cell.

Inhibitions up to 20 per cent by nicotine (0.01 *M*) were recorded with glucose. Activations up to 40 per cent by nicotine (0.01 *M*) were recorded with glucose-6-phosphate.

In view of these results, it became of interest to investigate the effect of nicotine on the hexokinase reaction. Partially purified hexokinase^{2,3} was prepared from yeast. Activities were measured at 30° in bicarbonate buffer, pH 7.5, by the method of Colowick and Kalckar³ using the Warburg apparatus. Nicotine (0.01 *M*) had no effect on the transfer of phosphate from adenosine triphosphate to glucose.

The significance of these findings is best appreciated by reference to the diagram.



Fluoride (0.01 *M*), which does not inhibit hexokinase⁴ or glucose-6-phosphate dehydrogenase⁵, inhibits glucose dehydrogenase activity of yeast by 30–40 per cent.

So far as we are aware, glucose dehydrogenase has not hitherto been reported as occurring in yeast.

In its behaviour towards nicotine, we find that the glucose dehydrogenase activity of yeast resembles that of the enzyme⁶ in mammalian liver. Liver glucose dehydrogenase was prepared and purified by the method of Brunelli and Wainio⁷. Its activity was measured by determining the oxygen uptake of a system containing, in addition to the enzyme, glucose, coenzyme I, Straub's heart flavoprotein⁸ and methylene blue. Nicotine (0.01 *M*) inhibited by 15–18 per cent.

Glucose dehydrogenase activity, similarly inhibited by nicotine, occurs also in *Torulopsis utilis*.

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Oxidation of Glutathione in Extracts of Lens in the Presence of Ethylenediaminetetraacetate

CHELATING agents are being increasingly used for removing traces of metals. We therefore think it worth while to report a case where a chelating agent accelerated the oxidation of a substance which it was intended to preserve in the reduced state.

We extracted cattle lens with a neutral solution of ethylenediaminetetraacetate (EDTA, versene, sequestrene) to give a final concentration of 0.0087 *M* ethylenediaminetetraacetate with the object of removing traces of metals and thereby keeping the glutathione present in the extract fully reduced. We found that ethylenediaminetetraacetate promoted the oxidation of glutathione, which was stable in its absence for at least five days at 4° C. (Exp. 1, 2). The oxidation in ethylenediaminetetraacetate extracts was much slower in nitrogen (Exp. 3). Glutathione was not oxidized in the presence of 0.0013 *M* ethylenediaminetetraacetate unless the lens extract was also diluted (to 1 in 15) (Exp. 4, 5). There was no change in protein sulphhydryl measured by titration with *o*-iodosobenzoate.

of ascorbic acid in lens extract remained almost unchanged for two days in the presence of ethylenediaminetetraacetate while glutathione was oxidized, but ascorbic acid was decreased on the fifth day when there was little glutathione left in the solution. Ascorbic acid is stable for at least five days (Exp. 2) in the absence of ethylenediaminetetraacetate. Further evidence pointing to ascorbic acid as the substance which directly causes glutathione oxidation is the fact that if ascorbic acid is removed from a water extract of lens by dialysis, and ethylenediaminetetraacetate and glutathione are then added to it, the glutathione is stable (Exp. 6); but if ascorbic acid is also added, oxidized glutathione is formed (Exp. 7). This takes place in either a water or in an ethylenediaminetetraacetate extract of lens (Exp. 8).

It is quite difficult to remove oxidized glutathione completely from lens proteins. It dialyses rather slowly out of lens extracts (Exp. 9), and repeated precipitation of lens protein with 50 per cent ammonium sulphate takes down relatively more oxidized glutathione than reduced glutathione (Exp. 10). We thought at first that the loss of glutathione in extracts of lens made in ethylenediaminetetra-

Exp. No.	Lens extract made with	Days at 4° C.	Mgm./100 gm. fresh lens			
			Glutathione	Oxidized glutathione	Glutathione + oxidized glutathione	Ascorbic acid
1	0.0087 <i>M</i> ethylenediaminetetraacetic acid	0	266	2	268	43.4
		2	142	108	250	38.4
		5	42	162	204	21.6
2	Water	0	224	—	—	55.0
		2	240	—	—	52.8
		5	240	—	—	51.2
3	0.0087 <i>M</i> ethylenediaminetetraacetic acid	0	222	—	—	—
		2	151	—	—	—
		5	206	—	—	—
4	0.0013 <i>M</i> ethylenediaminetetraacetic acid	0	256	0	256	—
		2	246	0	246	—
		5	273	0	273	—
5	0.0013 <i>M</i> ethylenediaminetetraacetic acid (1:15 lens extract)	0	201	34	235	—
		2	140	19	159	—
		5	131	18	149	—
6	Water. Dialysed 2 days then ethylenediaminetetraacetic acid to 0.0087 <i>M</i> and glutathione added	0	222	0	222	—
		2	184	34	218	—
		5	—	—	—	—
7	Water. Dialysed 2 days then ethylenediaminetetraacetic acid to 0.0087 <i>M</i> and glutathione and 23 mgm. ascorbate/100 gm. lens added	0	202	2	204	—
		2	150	57	207	—
		4	117	84	201	—
8	0.0087 <i>M</i> ethylenediaminetetraacetic acid. Dialysed 2 days against distilled water then ethylenediaminetetraacetic acid to 0.0087 <i>M</i> and glutathione and 47 mgm. ascorbate/100 gm. lens added	0	90	74	164	—
		2	0	13	13	—
		5	90	74	164	—
9	0.0087 <i>M</i> ethylenediaminetetraacetic acid 2 days at 4° C. Followed by 2 days dialysis against distilled water	0	8	20	28	—
		2	—	—	—	—
		5	—	—	—	—
10	0.0087 <i>M</i> ethylenediaminetetraacetic acid 2 days at 4° C. Protein twice precipitated with ammonium sulphate and redissolved	0	234	—	—	—
		2	241	—	—	—
		4	146	—	—	—
11	0.0087 <i>M</i> ethylenediaminetetraacetic acid	0	216	—	—	—
		2	—	—	—	—
		4	—	—	—	—

Glutathione was estimated by the nitroprusside reaction¹ or by glycylase²; oxidized glutathione was estimated after electrolytic reduction to glutathione³. Ascorbic acid was estimated by titration with 2:6 dichlorophenolindophenol after precipitation of protein with metaphosphoric acid. Lens extracts were prepared from the lenses of freshly killed cattle by grinding with sand, extracting with twice their weight of fluid and centrifuging at 7,000 *g* for 5-10 min.

A solution of glutathione in 0.0087 *M* ethylenediaminetetraacetate is more stable than a solution in water, which suggests that oxidation of glutathione in ethylenediaminetetraacetate extracts of lens is secondary to some other reaction, such as the oxidation of ascorbic acid. This is known to be catalysed by ethylenediaminetetraacetate in the presence of metal ions and oxygen¹. A lens extract normally contains both ascorbic acid and glutathione, and it is therefore possible that when ethylenediaminetetraacetate is added to such an extract it catalyses the oxidation of ascorbic acid, which is then non-enzymically reduced by glutathione which itself becomes oxidized. Experiment 1 shows that the level

acetate might indicate formation of a protein-glutathione compound similar to the compound of glutathione and glyceraldehydephosphate dehydrogenase described by Krimm and Racker⁴. Glutathione could be liberated from this compound by boiling, and we have found that boiling will regenerate glutathione in lens extracts (Exp. 11). But it is known that if oxidized glutathione is heated with proteins it becomes reduced through reaction with protein-sulphydryl groups, and it is clearly this reaction that takes place when stored ethylenediaminetetraacetate extracts of lens are boiled.

It is possible that ethylenediaminetetraacetate will have a similar effect in extracts of tissues other

than lens and so destroy the substance its presence is intended to preserve.

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Lipid Nomenclature

CONSIDERABLE confusion exists in the naming of compounds of the class now most commonly referred to as 'lipids'. It is indeed not yet agreed that the latter shall be the generic name, and the terms lipins, lipines, lipides and lipoids are in current use, together with derivative forms, galactolipins, etc., used to designate the complex members of the class. A profusion of empirical nomenclature has developed, particularly in the complex lipid field, often referring to compounds of dubious existence, and terms are frequently applied without distinction both to a single compound and to a crude 'fraction' containing this compound or possessing similar solubility properties. Several authors have directed attention to this state of affairs^{1,2}, and have made proposals for rectifying some of the anomalies.

Folch-Pi and Sperry¹ have suggested the replacement of the older system of classification, in which the phosphorus-containing lipids or phosphatides were divided into the monoaminophosphatides (lecithin and cephalin) and diaminophosphatides (sphingomyelins), by a division into phosphoglycerides, phosphosphingosides and phosphoinositides. The former use of the term 'phosphatide' to cover all the phosphorus-containing lipids is rejected in favour of a system in which the diacylglycerophosphoryl radical is termed 'phosphatidyl', 'lecithin' becoming 'phosphatidyl choline' and the 'cephalins' 'phosphatidyl serine', 'phosphatidyl ethanolamine', etc. This classification is very convenient and has won ready acceptance by many workers. The diacylglycerophosphates are already referred to as 'phosphatidic acids', which is in conformity with the proposed usage, although the former term seems preferable as being definitive and is not too cumbersome. 'Phosphoglycerides' is not very satisfactory as a name for the group, suggesting the 'phosphatidic acids' rather than their esters with hydroxyamino compounds. It is therefore suggested that it is replaced by 'phosphoglyceratids'. In view of the recent synthesis³ of lipids in which glycol replaces glycerol in a lecithin type of structure, 'phosphoglycerolates' or 'phospholates' is suggested as a suitable term, 'phospholatidyl choline', for example, designating an acylglycolphosphorylcholine. The retention of 'ol' in the latter term involves a minor inconsistency with the phosphoglyceratids, in which the 'ol' of glycerol is omitted. However, the alternative, 'phosphoglyceratids', might involve confusion with sugar derivatives.

The term 'phosphosphingoside' proposed to replace sphingomyelin is very misleading, since the '-oside' termination suggests a glycoside and would lead to confusion with the sphingoglycosides (*q.v.*). An alternative term which would indicate the connexion with the phosphoglyceratids would be 'phosphosphingatids', although objection could be justifiably

Older terms	Alternative proposals in the literature	Present proposals
Lipid, lipide, lipin, lipine and derivatives Monoaminophosphatides Lecithin, cephalin	Phosphoglycerides Phosphatidyl choline Phosphatidyl ethanolamine, etc. Glycollecithins (ref. 3)	Lipid and derivatives, for example, phospholipid, galactolipid, etc. Phosphoglyceratids Phosphoglyceratidyl choline or phosphatidyl choline Phosphoglyceratidyl ethanolamine, etc. Phosphoglycerolates or phospholates Phosphoglycerolatidyl choline or phosphatidyl choline, etc. Phosphosphingamides or phosphosphingamides Phosphosphingamyl choline or phosphosphingamylidyl choline, etc. Sphingolipids Sphingoglycosides
Di- and triaminophosphatides Sphingomyelins	Phosphosphingosides Sphingolipids (ref. 4) Glycosphingosides Sphingoglycosides	Sphingolipids Sphingoglycosides Sphingamides
Cerebrosides	—	—
Ceramides	—	—

raised that no O-acyl group is present. It might therefore be more desirable to use a term such as 'phosphosphingamides', leading to 'phosphosphingamidyl choline' for the sphingomyelins already known, or, for a given individual, 'N-lignoceryl-phosphosphingamidyl choline' and allowing scope for extension as compounds of this structure, but involving other bases, are discovered or synthesized. However, the objection raised to 'phosphoglyceride' would apply to this term, and 'phosphosphingamitide' might overcome this point.

Lignoceryl-sphingosine and similar sphingosine amides at present styled 'ceramides' might be more suitably named 'sphingamides'.

Since the structures of the compounds termed 'phosphoinositides' by Folch-Pi and Sperry have not been established with any certainty, any attempt to include these in an analogous terminology would be premature.

Carter and Colmer (*loc. cit.*) prefer the term 'sphingoglycosides' to 'glycosphingosides', which was proposed by Folch-Pi and Sperry to replace 'cerebrosides'; and since, as the former authors point out, the compounds are glycosides, the point seems well taken.

It would seem to be extremely desirable for the appropriate International Union to go into the whole question of lipid nomenclature, in order that a generally acceptable terminology might be adopted.

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¹ Folch-Pi, J., and Sperry, W. M., "Ann. Rev. Biochem.", 17, 147 (1948).

² Colmer, W. D., and Carter, H. B., *Physiol. Rev.*, 33, 167 (1953).

³ Bear, H., *J. Amer. Chem. Soc.*, 75, 622 (footnote) (1953).

⁴ Carter, H. B., Haines, W. J., Ledyard, W. H., and Norris, W. P., *J. Biol. Chem.*, 109, 77 (1947).

Sex Ratio in Spawning Populations of *Lampetra planeri*

THE question of the sex ratio in lampreys is of some interest in view of the occurrence of hermaphrodite gonads in the ammocoete larva; but there are wide divergencies in the figures given by previous workers in Europe and North America.

My own observations on *L. planeri* show that the ratio varies in different streams and even from year

Table 1

Year	Total seen or captured	No. of visits	No./visit	Males	Females	Ratio: male/females
1947	83	3	28	60	23	2.6
1949	64	5	13	35	29	1.2
1950	126	6	21	90	36	2.5
1951	182*	8	23	100	46	2.2
1952	118*	7	16	56	33	1.8
1953	197*	9	22	143	54	2.6

* Total includes animals not sexed.

to year, and suggest that such variations may be responsible for these conflicting reports.

Table 1 records the results of systematic observations on the River Yeo (north Somerset) over a period of six years and, except for 1947, these observations were maintained from the first appearance of the adults in late March or early April to their final disappearance at the end of April. Visits were spaced at intervals of three or four days, and on each occasion a complete search was made of the restricted stretch of the stream where the animals occur. As an objective index of relative frequency the number of animals seen or captured per visit is to be preferred to the total number, as the latter takes no account of the varying durations of the spawning season and differences in the number of visits made from one year to another.

The total figures for the six years give a ratio of 2.2, and on only one day in the whole period has the number of females exceeded the males, while for more than half the observation days the males have exceeded the females by more than 2:1.

The records do not bear out the findings of Zanandrea¹ that the excess of males increases as the season advances, or his suggestion that this is due to the greater survival-rate of the male. In 1951, when spawning reached its peak later than in any other year, the ratio was 2.2; yet in 1950, when it occurred some three weeks earlier, the proportion of males was even larger (2.5). Moreover, if the numbers are grouped as weekly totals the smallest proportion of males is to be found in the last week of the spawning season.

The annual variations in sex ratio are interesting when compared with the estimates of relative total numbers. Thus, in the years 1949 and 1952 when the total population was smallest the sex ratio was only 1.2 and 1.8 as against 2.6, 2.5 and 2.2 in the years when the total population was greater. Excluding 1947, when only three visits were made, the number of females in any one year varied only from 29 to 54 as against 35 to 143 for the males. Variations in total numbers have therefore been due in large part to variations in the number of males.

Collections from a small area in south-east Somerset in 1938 and 1939 consisted of 139 males and 129 females, and in each year the sexes were present in nearly equal numbers². These local and annual differences in the sex ratio suggest that the orientation of sex in the ammocoete is influenced by environmental conditions such as temperature and nutrition.

Note added in proof. The results recently obtained for 1954 are consistent with those of previous years in showing a low ratio of males to females (1.6) with a relatively small total population (total 126 and number observed per visit 16). M. W. HARDISTY

College of Technology,
Unity Street, Bristol 1. Jan. 15.

¹ Zanandrea, G., *Boll. Pesc. Pisc. Italoobol.*, 6 (1951).

² Hardisty, M. W., *J. Animal Ecol.*, 12, 2 (1944).

A Violet Pigment from the Mediterranean Medusa *Rhizostoma pulmo*

In the subtentacles and marginal bodies of the Mediterranean medusa *Rhizostoma pulmo* a violet pigment occurs which can be extracted by means of distilled water at 2°–4°. By filtering and evaporating to dryness the deep violet-coloured solution in vacuum, and redissolving it three or four times, we finally obtained an amorphous violet residue, insoluble in common organic solvents, but giving with antimony trichloride in chloroform a blue carotenoid-like reaction. The violet colour is constant between pH 1.4–10.0. Over and below this pH it becomes pink. Addition of hydrogen peroxide decolorizes the solution. The violet solution shows a bluish fluorescence in ultra-violet light, and a characteristic absorption spectrum with three peaks at 6150 Å, 5750 Å and 5250 Å (Fig. 1).

On heating the pigment solution over 50° it becomes brownish-yellow with precipitation of denatured protein and simultaneous disappearance of the absorption bands.

The pigment is probably a conjugated protein with a prosthetic group belonging, or related, to the carotenoids. This conclusion is adopted because of the similarity of the reaction with antimony trichloride, and the decolorization with hydrogen peroxide, as also to the resemblance of the spectrum.

Further researches are in progress.

Investigations concerning the composition of the mesogloea from *Rhizostoma pulmo* have produced evidence that its proteins are very poor in total nitrogen (20–28 mgm. per cent nitrogen) and is partially conjugated with silicon.

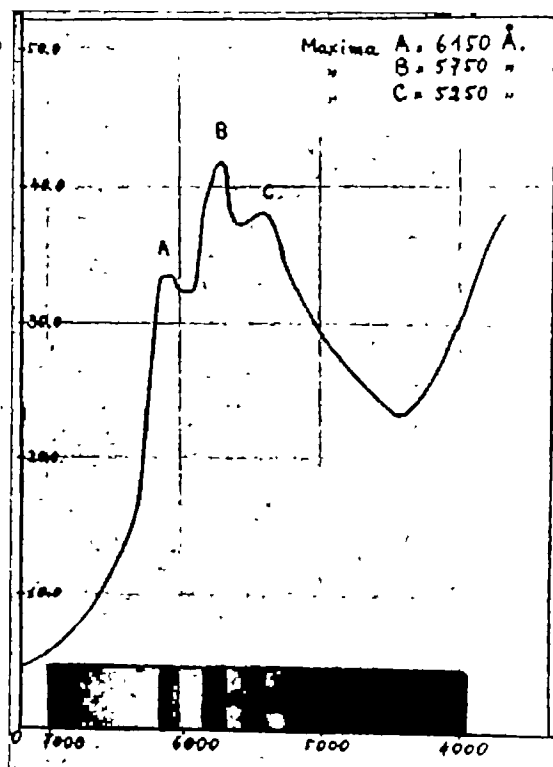


Fig. 1



Fig. 2. 1, Phenylalanine; 2, isoleucine; 3, leucine; 4, tyrosine; 5, valine; 6, proline; 7, methionine; 8, arginine; 9, lysine?; 10, alanine; 11, glycine; 12, serine; 13, threonine?; 14, unidentified; 15, ammonium salts; 16, aspartic acid; 17, glutamic acid; 18, glucosamine

Chromatograms show that the jelly tissue yields, after hydrolysis, in addition to glutamic acid, leucine, isoleucine, valine, aspartic acid, arginine, perhaps lysine, proline, methionine, alanine, glycine, serine, an amino-acid travelling with threonine, and at least two unidentified amino-acids of which one (No. 18) could be (it is not yet definitely proved) glucosamine (Fig. 2).

Fuller details of this work will be published in the *Bulletin of the Academy of Sciences, Athens*.

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Chromosome Counts in Tunicates and a Modified Method for making Permanent Squash Preparations

WHEN collecting tunicates at the Marine Biological Station at Roscoff (Brittany) we wondered whether it would be possible to introduce the cytogenetical element into tunicate systematics. To this end we tried acetocarmine squashes after preliminary soaking in distilled water as recommended by Makino and Nishimura¹. The method worked well; but owing to the small size of cells and chromosomes our microscope outfit did not provide a sufficient resolving power. We then made permanent preparations for examination at home. The method of Makino and Nishimura¹ for making permanent squash preparations not giving satisfactory results, we modified the method and adopted the following procedure.

(1) Dissect the material in distilled water and leave it to soak for a few minutes. (2) Transfer to cold acetocarmine (40 per cent glacial acetic acid) and leave the material to fix and stain for at least thirty minutes, but in general no longer than forty-five minutes. Should the material be left too long in the acetocarmine or should it be heated in it, it will not squash well. (3) Place the fixed and stained material on a heavily albuminized slide. (4) Moisten one side of a piece of 'Cellophane' with albumin and place the

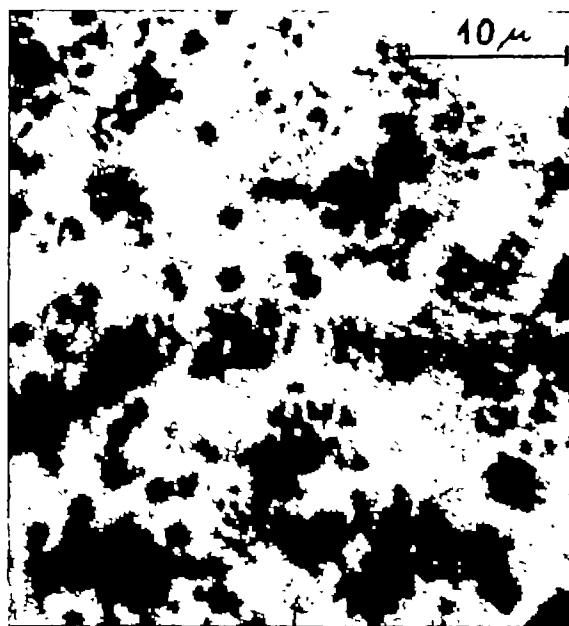


Fig. 1. Microns in *Aspidium proterum*

'Cellophane' on the material, the moistened side downwards. Flatten out creases and remove air bubbles. (5) The material under the 'Cellophane' is now rolled out by means of a glass rod or squashed by application of pressure with a cover-slip. (6) Heat the slide gently by passing it over a small flame a few times, then place it quickly in a dish with distilled water. The heating should be just sufficient to allow for the coagulation of the albumin close to the slide. If the heating was insufficient the material will come off together with the 'Cellophane' in the distilled water. If the heating was too great the 'Cellophane' will not come away and the material may be damaged. The correct amount of heating, which

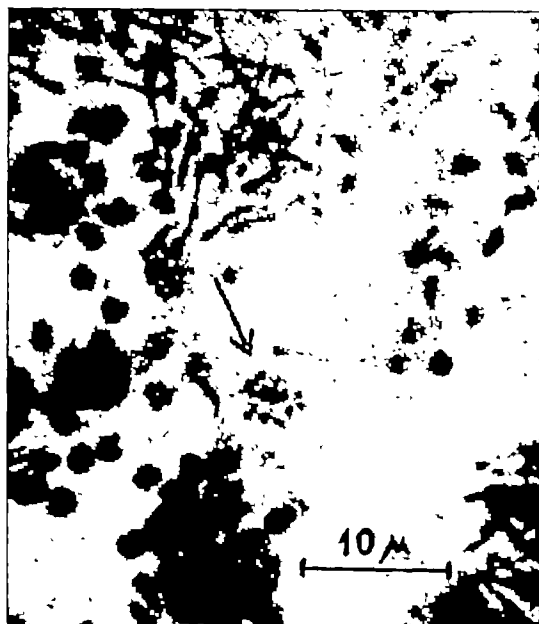
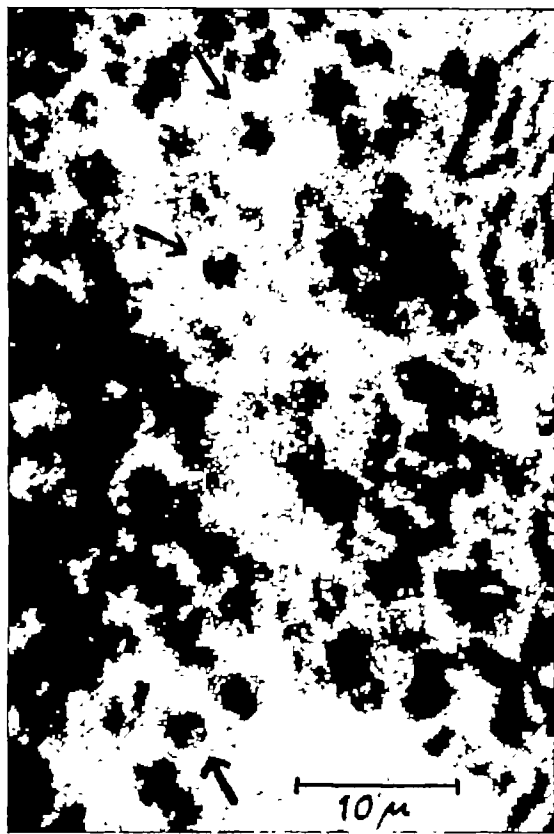


Fig. 2. Microns in *Siphon elegans*

Fig. 3. Meiosis in *Pyura microcosmus*

can only be learned by personal experience, ensures that the 'Cellophane' floats off, while the squashed material adheres to the slide. (7) Dehydrate and mount in the ordinary manner.

Employing this procedure, we made permanent acetocarmine squash preparations of whole abdomens of *Aplidium proliferum* (Milne Edwards), *Sidnyum elegans* (Giard) and *Sidnyum turbinatum* (Savigny) and of pieces of gonads of *Pyura microcosmus* (Savigny). These were examined in Amsterdam with the aid of a fluorite oil-immersion objective.

We found suitable stages of meiosis in preparations of *Aplidium proliferum* (Fig. 1), *Sidnyum elegans* (Fig. 2) and *Pyura microcosmus* (Fig. 3). Our count for *Aplidium proliferum* was $n = 14$, for *Sidnyum elegans* $n = 9$ and for *Pyura microcosmus* $n = 8$.

So far as is known to us this is the first instance in which chromosomes have been observed in tunicates. Although the tunicates are far from ideal for cytogenetical work, on account of the small size of the chromosomes, such cytogenetical work does not seem impossible.

Our modified method for making permanent squash preparations has also been tried with fair results on botanical material (anthers). Botanical material may require a different staining procedure.

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Distribution and Chromosome Number of *Allium paradoxum* in Gloucestershire

There is only one record of *Allium paradoxum* (M. Bieb.) G. Don. in the 'Flora of Gloucestershire' (p. 465; 1948). During a study of the ecology of this population at Bartonbury, other centres have been located near Chesterton and on the Bath Road. The chromosome number of the species has been investigated in Feulgen squashes¹ of root tips treated with mono-bromo naphthalene², and in aceto-carmine¹ and Feulgen squashes¹ of anthers. The chromosome number found in the Bartonbury populations is $2n = 16$. Pollen grain mitosis has been observed in detail and records are as follows:

Plants	Pollen grains at metaphase	Haploid chromosome number	
		8	7
15	107	106	1

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Feb. 26.

¹ Darlington, C. D., and LaCour, L. F., 'Handling of Chromosomes' (Allen and Unwin, 1947).

² O'Mara, J. C., *Stain Tech.*, **23**, 201 (1948).

Hatchability of Hen Eggs and Lymphomatosis

It is widely accepted that poor hatchability is one of the main causes of financial loss to poultry breeders. Judging from the results regularly reported by many large hatcheries, the national hatching-rate of all eggs set in Great Britain seems to be between 65 and 70 per cent.

The failure of an egg to hatch may be due—apart from defects in the incubator—to infertility or to some factor, often a nutritional deficiency, which causes the developing embryos to die at varying stages during the full term of twenty-one days. Fertility is now accepted as a heritable factor¹ and has no obvious relationship with embryonic mortality, although by many poultry breeders the two conditions are regarded under the one heading of 'hatchability'. There are some grounds for this in that attention to one factor, for example, fertility, usually leads to greater attention to the other and, as a consequence, improved fertility is often accompanied by lower embryonic mortality. Moreover, it is impossible merely by candling to distinguish between infertile eggs and fertile eggs in which very early embryonic death has supervened.

Lymphomatosis is a further cause of reduced profits in the poultry industry, and in its several manifestations is probably responsible for approximately 25 per cent of the adult mortality among domesticated fowl in Britain². In endeavouring to breed lines resistant to this disease, it was observed that those dams which appeared most satisfactory on grounds of high egg numbers and high hatching-rate of all eggs set most frequently proved to be those having progeny among which the incidence of lymphomatosis was greatest. In consequence, these families were discarded. Inspection of the records over the several years revealed the fact that a remarkably close correlation between high hatchability and the incidence of lymphomatosis in the

¹ Makino, S., and Nishimura, I., *Stain Tech.*, **27**, 1 (1952).

Table 1. HATCHING RESULTS WITH DAMS THE PROGENY OF WHICH HAD NO LYMPHOMATOSIS OVER FIRST EIGHTEEN MONTHS OF THEIR LIVES

	Eggs set	Infertile	Hatch of fertile eggs	Per cent
1950	897	149	639	85
1951	1,189	306	656	74
1952	1,243	152	809	74
1953	2,668	248	1,877	81

HATCHING RESULTS WITH DAMS THE PROGENY OF WHICH EVINCED LYMPHOMATOSIS OVER FIRST EIGHTEEN MONTHS OF THEIR LIVES

	Eggs set	Infertile	Hatch of fertile eggs	Per cent
1950	1,492	76	1,279	90
1951	2,309	381	1,908	80
1952	1,786	178	1,235	79
1953	985	110	758	86

progeny of dams evincing high hatchability was apparent each year since lymphomatosis became manifest in the flock (Table 1).

Inquiries among a small number of flock owners who keep complete records have indicated that a similar parallelism is found. Lymphomatosis is present in varying degrees of intensity in the flocks of most breeders in Britain although in many the incidence on the farm is extremely low. Pedigree breeders rarely have post-mortem examinations carried out on every bird dying, still less on birds culled as 'poor doers', although such birds may be affected by lymphomatosis. Nevertheless, many breeders are reluctant to breed from full sister groups where one bird or more has died or has had to be culled. It may therefore be that, if this policy no longer operated, the incidence of lymphomatosis—already high—might become higher, and progress towards improved hatching-rates among first-class pedigree breeders may be possible only when the full implications of lymphomatosis are more fully understood.

The relationship between the disease and hatching-rates is not obvious and further investigations are being pursued by us.

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Feb. 6.

¹ Blyth, J. S. S., *Proc. Roy. Soc. Edin.*, **68**, 191 (1945).

² Colles, R., *Poultry Science* (in the press, 1954).

Relationship of Oestrogen and Progesterone in Oestrous Behaviour of the Ewe

It has been clearly demonstrated that for oestrus to accompany ovulation in the sheep the animal must have been under progesterone influence for several days¹⁻⁴.

In attempts to elucidate this phenomenon two series of experiments were conducted between June 1952 and December 1953 at the State Research Farm, Werribee. In the first series, twelve ovariectomized Suffolk cross-bred ewes were used in two groups, A and B, of six ewes each. Each group received the same level of oestradiol benzoate in oil, one group also receiving 75 mgm. progesterone, in six divided injections each of 12.5 mgm. for three days, commencing five days before oestrogen injection. Treatment was repeated at fourteen-day intervals for three treatments at each level of oestrogen, from 5 mgm. successively down to 8 µgm. by a factor of 0.2. At the end of each six-week period the groups were

switched; that group which had received oestrogen alone for the three preceding treatments received progesterone before each of the succeeding three treatments, and vice versa. The level of 8 µgm. was below the threshold for response, so the level was raised to 20 µgm. for the three concluding treatments.

At no level of oestrogen injection was it possible to induce oestrus regularly in a high proportion of ewes treated. When progesterone preceded oestrogen, regular cycles of oestrous behaviour were readily induced by all levels of oestrogen down to 40 µgm. A level of 20 µgm. appeared marginal. Between the limits of 5 mgm. and 40 µgm. oestradiol benzoate, the number of ewes treated, the number and the percentage responding, of progesterone-oestrogen and oestrogen-treated animals were: 96, 86, 90 per cent and 72, 21, 29 per cent, respectively. Progesterone pretreatment advanced the time of onset of oestrus by 12-24 hr.

The second series of experiments consisted of seven assay-type trials, involving seventy-two ovariectomized cross-bred Suffolk ewes, conducted at 4-weekly intervals from June until December 1953. All ewes were primed midway between each trial with 50 µgm. oestradiol benzoate. Dose-response lines were obtained for progesterone-oestrogen and oestrogen alone. In the last two trials, direct comparisons were made, using criteria of oestrous behaviour and vaginal smear change. Progesterone pretreatment reduced the median effective dose of oestradiol benzoate, for oestrus from 64 µgm. to 22 µgm. (99 per cent fiducial limits 52-81 and 19-26), and for vaginal cornification from 24 µgm. to 14 µgm. (99 per cent fiducial limits 20-28 and 10-17). When progesterone preceded oestrogen, the nature of the reaction appeared changed: the dose-response line was steeper and the onset of oestrus earlier.

It is concluded, therefore, that oestrus in the ewe is under dual progesterone-oestrogen control and that this accounts for the phenomenon of 'silent oestrus', or ovulation without oestrus, which occurs at the first ovulation of the breeding season, or when ovulation is induced by gonadotrophin injection in anoestrus.

Full details of these experiments are being published elsewhere, where acknowledgment will be made to the various individuals and organizations who have given valuable aid in this research.

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¹ Dutt, R. H., *J. Animal Sci.*, **11**, Proc., 792 (1952).

² Dutt, R. H., *J. Animal Sci.*, **12**, 515 (1953).

³ Robinson, T. J., *Nature*, **170**, 373 (1953).

⁴ Robinson, T. J., *J. Endocrinol.*, **10**, 117 (1954).

Presence and Absence of the Pre-Natal Check in Lambs' Birthcoats

Fraser, with Hamada¹, has stated that non-N-type and N-type lambs differ in the presence of the pre-natal check in the former and its absence from the latter, and this view is adopted by Waddington².

Sickle-fibres constitute the most easily perceived evidence of the pre-natal check²⁻⁴. Of ten N/+ N-grade lambs studied in a number of body regions, all had sickle-fibres on the shoulder patch and shoulder,

and they were present on several necks, withers, sides and backs, but not on any britch. On eight of the shoulder patches fine sickle-fibres were present.

Sickle-fibres are less plentiful on *N/N* lambs. They have been recorded before on the side (D. A. Ross and F. W. Dry), but they have not been found on the back (Janet M. Ross and Wright). On only one of six *N/N* lambs examined recently on seven positions have sickle-fibres been found anywhere but on the shoulder patch, namely, chalky sickle-fibres on the neck and side, and fine sickle-fibres on the shoulder patch region. Seven of twelve additional *N/N* lambs had sickle-fibres on the shoulder patch region; none of these was fine sickles. Super-sickle-*B* fibres, which have part of the neck region fine and non-medullated, also reveal the presence of the pre-natal check. They have been found on several body regions of a number of homozygotes. Sickle-fibres are easy to find on recessive-*N*'s, but the details need not be given now.

Sickle-fibres have been found low on the leg of six weeks' old *+/+*, *N/+* and *N/N* lambs. The covering looked like that of a short-coated wild sheep, but the hind-legs of Romneys can come later to be more or less woolly down to the hoofs.

In a specimen out from the hip of a three weeks old Mouflon, kindly supplied by Mr. P. G. Schinckel, of Roseworthy Agricultural College, a pre-natal check is revealed by an array tentatively called saddle. Fibres with an apical end approaching the characteristic sickle form, but less sharply curved at the butt of the apical curve and becoming finer more gradually, have a finely crimped neck region and, doubtless following the birth point, become coarser basally. The pre-natal check is thus recognized in a wild sheep. By contrast, in a specimen from the pelt of a nine-day Barbary lamb, for which we are also indebted to Mr. Schinckel, there is nothing to interpret as evidence of a pre-natal check, although some of the short finest fibres, which are crimped, have an apical curve faintly suggestive of a sickle-end.

There is need for much more work and thought on the mechanism of the pre-natal check and its place in the evolution of the fleece.

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Fraser and Hamada, *Proc. Roy. Soc. Edin.*, B, 44, 402 (1953).
Waddington, *Quinquennial Report 1947-1951 of the Institute of Animal Genetics, University of Edinburgh* (1953).
Dry, *J. Text. Inst.*, 34, T161 (1943).
Dry, *N.S. J. Agric.*, 43, 331 (1934).
Dry, *N.S. J. Sci. Res.*, 5, 60 (1953).

Delayed Implantation in the Harbour Seal, *Phoca vitulina* L.

PUBLISHED observations on harbour seals generally have indicated the belief that mating in this species, at least in temperate zones, occurs in August and September, with a peak in September. The reasons for this apparently are twofold. First, the animals seem to be more gregarious at hauling-out sites in August and September than at other times of the year, and display more than the usual amount of quarrelsome and noisy activity then. This has

been taken to indicate sexual activity, and seal hunters have reported apparent acts of copulation at this time. Secondly, small embryos taken in October and November are of such a size as to suggest that implantation took place in August or September. Schaffer and Slipp¹ give the curvilinear length of an embryo taken in Washington State between September 12 and 15 as 103 mm., and state that spermatogenesis begins early in July. Havinga² gives the length of the smallest embryo seen by him as 10 cm., taken in December, and states that mating in Dutch waters takes place in August and September. Imler and Sarber³ state that while the mating season is unknown, embryos taken in Alaska from a fraction of an inch to about 1½ in. in length are found from mid-October to well into November. Fisher⁴ reported that the testes of a large male harbour seal taken in British Columbia on September 25 were sexually active, and thought that mating occurred at this time of year.

During the past few years, harbour seals from Nova Scotia and New Brunswick have been examined at St. Andrews, N.B., as a part of general life-history studies of pinnipeds on the Canadian east coast. A series of forty-eight reproductive tracts of adult female harbour seals taken from May to October since 1950 has yielded interesting information on the reproductive cycle in this species. Whelping in Nova Scotia and New Brunswick waters occurs in May and June with a peak early in June. A study of the ovaries has revealed that the corpus luteum of pregnancy in gross appearance persists throughout lactation (two to three weeks) as a large body, which looks functional, although it displays from late pregnancy early microscopic signs of retrogression similar to those outlined by Harrison, Matthews and Roberts⁵. Grossly visible signs of retrogression, with large mature follicles generally in the opposite ovary, have been noted as early as June 13. By early July retrogression is advanced, and new corpora lutea have been found as early as July 3. From this date until September 19, a well-spread series of thirty specimens shows a large (although smaller than maximum size attained) new fully filled-in corpus luteum in each set of ovaries, no mature follicles, and no evidence of implantation or embryonic development. Two reproductive tracts taken on September 20 and 21 each contained a typical implantation site in one cornu of the uterus, consisting of a small bulbous swelling about the size of a marble. One specimen on October 3, two on October 7, and one on October 11 contained embryos 4 mm., 9 mm., 15 mm. and 17 mm. long respectively. A series of embryos taken from this date until March shows progressive development from these sizes. No sexually mature females without embryos have been taken after September 20.

It appears, therefore, that harbour seals in the waters of Nova Scotia and New Brunswick, and probably elsewhere in similar latitudes, mate immediately upon the termination of lactation late in June or early in July, and that implantation is delayed until September. No evidence of copulation at any time has been obtained, and it is felt that copulation must take place chiefly in the water. There are the usual noisy gatherings of seals in August and September at hauling-out sites, but these it seems cannot be attributed to sexual activity.

Evidence gathered and being gathered by other workers in this field^{6,7} indicates that the phenomenon of delayed implantation is the rule in the family

Phocidae and probably in the eared seals as well. The results of work being carried out by other investigators on Arctic species should be available before long to help complete the picture.

A fuller treatment of the material mentioned here, together with the results of histological examination of a series of testes now in progress, will be presented in a later paper.

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March 2.

¹ Schoffer, V. B., and Elpp, J. W., *Amer. Mid. Nat.*, 53, (3) (1944).

² Havigs, B., *Thijsd. med. diark. Ver. Leiden*, (51), 3 (1933).

³ Imler, H., and Barber, H. R., U.S. Fish. Wild. Service, Spec. Sci. Rep., No. 28 (1947).

⁴ Fisher, H. D., Fish. Res. Bd. Can. Bull., No. 93 (1953).

⁵ Harrison, B. J., Matthews, L. H., and Roberts, J. M., *Trans. Zool. Soc. Lond.*, 57, Pt. 5 (1953).

⁶ Gabbney, L., *Nature*, 172, 4578 (1953).

Evolution and Epistemology

PROF. E. SCHRÖDINGER's recent book¹ discussing the relevance of ancient Greek thought to present-day scientific philosophy touches on very many of the problems which have been debated throughout the whole history of Western civilization. He closes it (p. 94) with the thought, adumbrated perhaps already by Democritus (see p. 80), that "for the purpose of constructing the picture of the external world, we have used the greatly simplifying device of cutting our own personality out, removing it . . . this is the reason why the scientific world-view contains of itself no ethical values, no aesthetic values, not a word about our own ultimate scope or destination, and no God, if you please".

But has not recent biological thought added to the picture a factor which Schrödinger fails to take into account? We believe now that the intellectual-sensory apparatus by which we make contact with the external world arose through a process of evolution. According to classical neo-Darwinian views, the process by which it came into being, and acquired the characteristics which it has in man, depended on the occurrence of random changes which were selecting according to their effectiveness in furthering the reproductive ability of the individual animals concerned. If this is true, it is no longer adequate to frame a discussion in terms of a dichotomy between "our personality" and an impersonal world which we arrive at by "cutting our personality out". The faculties by which we arrive at a world view have been selected so as to be, at least, efficient in dealing with other existents. They may, in Kantian terms, not give us direct contact with the thing-in-itself, but they have been moulded by things-in-themselves so as to be competent in coping with them.

I believe one can go further than this in asserting a congruity between our apparatus for acquiring knowledge and the nature of the things to be known. I have suggested² that evolution operates not so much by the differential reproduction of chance variations of phenotype, but by the selection of genotypes which endow their possessors with the capacity to react adaptively with their surroundings (adaptive being defined in terms of reproduction). From this point of view it is easier to envisage the possibility

that our mental equipment is not merely one that happens to be reasonably efficient, but that it has been shaped precisely to fit the character of those things with which it has to make contact. If this were so, the fundamentals of "our personality" must still be implicit in the scientific world-view, and attempts to find them there (such as a tentative one of my own³) cannot be dismissed as impossible of fulfilment.

C. H. WADDINGTON

Institute of Animal Genetics,
University of Edinburgh.
March 27.

¹ Schrödinger, E., "Nature and the Greeks" (Cambridge University Press, 1954).

² Waddington, C. H., *Nature*, 150, 563 (1943); *Evolution*, 7, 118, 336 (1953).

³ Waddington, C. H., and others, *Nature*, 143, 270 (1941); "Science and Ethics" (Allen and Unwin, 1943).

Forecasting Weather from Solar Radiation

I FEEL that the burden of Dr. C. E. P. Brooks's review of my recent paper (see *Nature*, Dec. 12, p. 1089) does me injustice.

I claim the discovery of a family of periodic variations, more than twenty in number, all to within 1 per cent, integral sub-multiples of 22½ years. For meteorological applications it makes no difference how I was led to make this claim. The question is: Does this family of periods occur in meteorological records?

In my paper in *Smith. Misc. Coll.*, Vol. 122, No. 4, 1953, a single illustration, Fig. 19, demonstrates five of these periods in the precipitation at Albany, N.Y., namely, 45½, 22½, 15½, 11½ and 9½ months. The range of these periodic variations is from 7 to 25 per cent of normal precipitation at Albany. In another paper, *Smith. Misc. Coll.*, Vol. 101, No. 1, 1941, I show that another of the periods, ½ of 22½ years, is associated with changes of temperature at Copenhagen, Vienna and New Haven, from 1800 to 1932, amounting to 1.2 deg., 1.1 deg. C., and 1.3 deg. F., respectively. Also in *Smith. Misc. Coll.*, Vol. 111, No. 13, 1949, I claim two periods in New York and Washington temperature. I now see that, to within one part in 8,000, these are 1/1,250 and 1/2,500 of 22½ × 365½ days.

By adding together in proper phases the effects of twenty-two periods on the precipitation at Albany, I make a prediction, thirty years in advance of its basis, for 41 months, 1928-31, which gives a correlation coefficient of 75 ± 7 per cent. I also add the effects of more than twenty periods, based on Washington temperature records of 1854-1939, which, according to Dr. Brooks, enables a prediction for 18 months of 1952 and 1953 to make a 2 for 1 score.

It seems to me that such results deserve fairer consideration than the saying: "But even granted that the solar constant does vary, the variations found by Dr. Abbot are so small—only one or two per cent—that their direct effect on surface temperatures would be barely perceptible". As stated above, the question, Does a family of periodicities, integrally related to 22½ years, occur in weather?, is quite independent of the question, Does this family occur in solar variation?

C. G. ABBOT

Smithsonian Institution,
Washington 25, D.C.

...London, Gore, London, at 8.15 p.m.—"Exploration of Roman

...at the Zoological Gardens, at 5 p.m.—Scientific Papers.

...ORGANIC FINISHING GROUP (at Management, Management House, Hill Street, at 8 p.m.—Discussion on "Cellulose v. Synthetics".

...LONDON (at the Institute of Archaeology, Inner Circle, London, N.W.1), at 8.15 p.m.—Dr. G. H. R. "Recent Work in Archaeology outside Europe"—(1) "South

Wednesday, May 12

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 8.30 p.m.—Mr. John N. Summerson: "The Society's House and Earlier Homes" (Peter Le Neve Foster Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. B. G. Hudson, Dr. M. Chaston and Mr. R. V. Browne: "The Geology of Jebel Qamar, Oman". Dr. D. H. Oswald: "The Carboniferous Basins between the Ox Mountains and Donagh Bay" (this paper will be read by Prof. T. Neville George).

ROYAL STATISTICAL SOCIETY, RESEARCH SECTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Symposium on "Interval Estimation".

NEWCOMEN SOCIETY (in the Lecture Theatre of the Science Museum, South Kensington, London, S.W.7), at 6 p.m.—Prof. Charles Singer: "First Dickinson Biennial Memorial Lecture".

Thursday, May 13

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Ian Hutton, F.R.S.: "Brewing in Relation to Natural Science".

LONDON MATHEMATICAL SOCIETY (in the New Chemistry Block, University of Sheffield, Sheffield), at 6 p.m.—Prof. A. M. Macbeath: "The Concept of 'Mapping' in Undergraduate Mathematics".

PHYSICAL SOCIETY (in the Rooms of the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. A. Kastler (France): "Les Methodes Optiques d'Orientation Atomique et Leurs Applications" (Ninth Holwade Lecture).

SOCIETY OF CHEMICAL INDUSTRY, FOOD GROUP (in the British Legion Room, Memorial Hall, Chorleywood, Herts), at 6.30 p.m.—Dr. J. B. M. Coppock: "Science and the Baker".

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. H. L. Cox: "The Use of Materials in the Plastic Range".

BRITISH PSYCHOLOGICAL SOCIETY (joint meeting with the BRITISH SOCIOLOGICAL ASSOCIATION, in the Tuke Hall, Bedford College, Regent's Park, London, N.W.1), at 8 p.m.—Prof. Otto Klineberg (Columbia University): "National Stereotypes: Scientific and Practical Implications".

Friday, May 14

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

UNIVERSITY COLLEGE LONDON (in the Anatomy Theatre, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. M. Ray Denny (Michigan State College): "Learning Theory and Experimental Extinction".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Harold Spencer Jones, F.R.S.: "The Scale of the Universe".

Saturday, May 15

BIOCHEMICAL SOCIETY (in the Department of Physiology, The University, Bristol 8), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in engineering, mathematics or physics, or equivalent qualifications) in the DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Mechanical Engineering Research Laboratory, East Kilbride, near Glasgow, to lead a small team on work initially concerned mainly with the general field of stress analysis, both analytical and experimental, and later including vibration and photo-elasticity.—The Civil Service Commission, Scientific Branch, 80 Old Burlington Street, London, W.1, quoting B.4315/54 (May 12).

ASSISTANT LECTURER (Grade B) in GEOLOGY to teach the subject to degree level.—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (May 15).

SENIOR LECTURER (graduate in pharmacy, with adequate teaching and research experience) in PHARMACOLOGY, and ASSISTANT LECTURER, Grade B, in (a) PHARMACOLOGICAL CHEMISTRY, and (b) CHEMISTRY, at Brighton Technical College.—The Director of Education, Education Office, 54 Old Steine, Brighton 1 (May 15).

ASSISTANT, Grade A (honours graduate in physics) in the APPLIED SCIENCE DEPARTMENT, to teach physics and mathematics up to advanced level G.C.E.—The Clerk to the Joint Education Committee, Wolverhampton and Staffordshire Technical College, Wolverhampton (May 17).

ASSISTANTS (2) (with a sound training in laboratory methods, both physical and chemical, and preferably with some fundamental training and experience in biological work) for work on the composition of fruits in connexion with research on the storage life and quality of apples.—The Secretary, East Malling Research Station, near Maidstone, Kent (May 17).

JUNIOR PHYSICIST to assist in physical and clinical work with radioactive isotopes.—The Secretary, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3 (May 22).

LECTURERS or SENIOR LECTURERS in MATHEMATICS, BOTANY, CHEMISTRY, and a LECTURER in CROP HUSBANDRY, at the University College of the Gold Coast.—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 22).

SENIOR PRINCIPAL SCIENTIFIC OFFICER (with first- or second-class honours degree or equivalent in mechanical or aeronautical engineering, with considerable engineering experience, and preferably with some knowledge of guided missiles or rocket propulsion, and a theoretical knowledge of gas dynamics), in the ROYAL AIRCRAFT ESTABLISHMENT ROCKET PROPULSION DEPARTMENT, to direct research and development work on liquid propellant rocket motors.—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting O.247/54A (May 22).

HEAD (with appropriate academic and teaching experience, and also with industrial and research experience) of the DEPARTMENT of METALLURGY.—The Registrar, College of Technology, Suffolk Street, Birmingham (May 28).

LECTURER/SENIOR LECTURER in PETROLOGY at the University of Sydney, Australia.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, May 29).

READER in RADIOCHEMISTRY.—The Registrar, University Office, 46 North Bailey, Durham (May 29).

LECTURER or ASSISTANT LECTURER in PHYSIOLOGY at the University of Malaya, Singapore.—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (May 30).

CHAIR of PHYSICAL or INORGANIC CHEMISTRY.—The Secretary, Queen's University, Belfast (May 31).

DEMONSTRATORS (3) (with a first- or second-class honours degree in chemistry, and a RESEARCH ASSISTANT (with at least two or three years experience in postgraduate research work) in the DEPARTMENT of ORGANIC CHEMISTRY.—The Registrar, The University, Liverpool (May 31).

LECTURER (with special qualifications in organic chemistry) in CHEMISTRY in St. Salvator's College.—The Secretary, University of St. Andrews, College Gate, St. Andrews (May 31).

LECTURER in PATHOLOGY.—The Secretary, University College, Cork, Ireland (May 31).

METALLURGIST (with a recognized degree in metallurgy, and preferably with one or two years industrial experience) at the Naval Research Establishment, Halifax, Nova Scotia, for duties which will include the examination of service metallurgical failures (ferrous and non-ferrous) in R.C.N. Ships, and undertake metallurgical research in the field of the improvement of metallurgical components in warships.—The Defence Research Member, Canadian Joint Staff, 66 Ennismore Gardens, London, S.W.7 (June 1).

LABORATORY TECHNICIAN (with wide experience in biochemical and/or chemical laboratories) in the DEPARTMENT of BIOCHEMISTRY, John Curtin School of Medical Research, Australian National University.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 7).

CHAIR of PHYSIOLOGY in the University of Sydney, Australia.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, June 30).

SENIOR LECTURER in METALLURGY at the University of Otago, Dunedin, New Zealand.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, July 1).

SENIOR LECTURER in PHYSICS at Rhodes University, Grahamstown, South Africa.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, July 1).

AGRONOMIST (with at least a second-class honours degree, and not less than two years appropriate postgraduate experience, preferably including acquaintance with tropical crops and up-to-date knowledge of the statistical analysis of field experimental results), at the West African Cocoa Research Institute, Gold Coast, to assist in laying down field experiments on various methods of cultivating cocoa.—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting Z7059/130.

ASSISTANT, Grade B (with a good honours degree of a British university, and preferably with teaching experience to degree standard) in the DEPARTMENT of PHYSICS.—The Principal, Technical College, Queen Street South, Huddersfield.

ASSISTANT LECTURER (graduate in physics, engineering or chemical engineering, and preferably with experience in the food industry)—The Registrar, National College of Food Technology, Cranwood Street, London, E.C.1.

DEMONSTRATOR in GEOLOGY.—The Registrar, The University, Nottingham.

REGULERS and PHYSICISTS (particularly with electronics), Senior Scientific Officer and Scientific Officer grade (with an appropriate first- or second-class honours degree, or equivalent high professional attainments) in Royal Naval Scientific Service Experimental Establishments in the London, Portsmouth, Weymouth and Gloucestershire

areas, and in Scotland—The Ministry of Labour and National Service, Technical and Scientific Register (K), 28 King Street, London, S.W.1, quoting A.946/52A.

FISHERIES OFFICERS (with a university degree in natural science) in the Gold Coast, to assist in the general development of marine and freshwater fisheries (Ref. ODB.65/13/01), and in the Northern Region of Nigeria to demonstrate and develop simple fish farming (Ref. ODB.149/14/02). The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting appropriate Ref. No.

MASTER or FRANCHISEMATE to advanced and scholarship level—The Headmaster, Bishop's Stortford College, Bishop's Stortford.

PHYSICAL CHEMIST (preferably with research experience on polymerization) to undertake fundamental research on resin finishes on textiles—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

PHYSICIST (with a first- or second-class honours degree in physics, and wide experience of high-speed photography including operation of electronically pulsed timing circuits) at the Ministry of Supply Designing Establishment, near Sevenoaks, Kent, to take charge of a small section employing photographic and optical techniques in investigation of transient phenomena associated with explosives—The Ministry of Labour and National Service, Technical and Scientific Register (K), 28 King Street, London, S.W.1, quoting A.103/54A.

PRINCIPAL SCIENTIFIC OFFICER (with first- or second-class honours degree in physics or equivalent qualification, and undertaken several years responsible research work) at the Atomic Weapons Research Establishment, Aldermaston, to supervise a group engaged on research and development work in relation to problems involving radioactive materials—The Administrative Officer, Recruitment, Atomic Weapons Research Establishment, Aldermaston, quoting 78/WGB/24.

SCIENTIFIC OFFICER, Grade 2 (with professional/academic qualifications, and preferably with industrial experience in metallurgy) in the Metallurgy Division at Derby—The Director of Research (Railways), British Railways Research Department, Staff Section, 222 Marylebone Road, London, N.W.1.

SCIENTIFIC OFFICER (with first- or second-class honours degree in physics or electrical engineering) at an R.A.F. Station near High Wycombe, Bucks, for operational research duties, and theoretical studies in the field of communications and general electronics—The Ministry of Labour and National Service, Technical and Scientific Register (K), 28 King Street, London, S.W.1, quoting A.100/54A.

SOIL CHEMIST (with a good honours degree in chemistry, preferably with training and experience in soil chemistry) in Kenya, to analyse soils in connexion with research into the uses of fertilizers on crops, and into the development of areas of irrigation—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODB.63/7/017.

ZOOLOGIST, Senior Scientific Officer or Scientific Officer grade (with first- or second-class honours degree), for general and experimental work on marine plankton—The Director, Marine Station, Millport, Isle of Cumbrae, Scotland.

National
(December)
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Ministry of
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ings under the Dis
H.M. Stationery Off
Institute of Person
(Occasional Papers—No. 4)
Management, 1954) 4s.
Fire Protection Associat
Organization. By S. H. Cl
tion from Burning Buildi
(London: Fire Protection A

Other C

University of Cairo. Publications of
Al Gharafa (Red Sea). No. 8: The Fish
Plectognath. Pp. 80+5 plates. (Cairo: 1953.)

Western Australia. Geological Survey. Bulletin
Geology of the Country About Coolgardie, Coolgardie
W.A. Part 1—Regional Geology. By J. C. McIlraith.
Selected Mining Groups. By N. M. Gray and H. J. Ward.
Supplementary Atlas to Bulletin 107: 24 maps (Perth, Government Printer, 1953.)

Indian Library Association. English Series 7: Union Catalogue of
Learned Periodical Publications in South Asia. Vol. 1: Physical and
Biological Sciences. Edited by Dr. S. B. Bhangathan and others.
Pp. 800. (Delhi: Indian Library Association: London: George
Blunt and Sons, 1953) 2s. rupees 9 dollars; 60s.

Agronomia Angolana. No. 7. Pp. xii+583+106 plates. (Luanda: Reparticao Central dos Servicos de Agricultura de Angola, 1953.)

U.S. Department of Agriculture. Farmers' Bulletin No. 1668: The
Red Harvester Ant and How to Control It. Pp. 11. 10 cents. Circular
No. 926: Effect of Soil Applications of Insecticides on the Growth and
Yield of Vegetable Crops. By M. W. Stone, F. B. Foley and D. H.
Bixby. Pp. 20. 10 cents. (Washington, D.C.: Government Printing
Office, 1953)

Bulletin of the Bingham Oceanographic Collection. Vol. 14, Article
2: Fish Endocrinology. By Grace E. Pickford, Sanford L. Palay,
Harriet A. Chambers and Ethel H. Ats. Pp. 116. (New Haven, Conn.
Peabody Museum of Natural History; Yale University, 1953.)
175 dollars

Institut Royal Meteorologique de Belgique. Publications Serie
B, No. 10. Transformation du Systeme de Contrôle du Chauffage du
Frigorimètre de Daves en vue d'Assurer une Constante Suffisante de la
Température de la Sphère. Par R. Dogniaux et W. Vandenborre.
Pp. 12. (Uccle-Bruxelles: Institut Royal Meteorologique de Belgique,
1953.)

Uganda Electricity Board. Sixth Annual Report and Accounts for
the year ended 31st December, 1953. Pp. 30+18 plates. (Kampala.
Uganda Electricity Board, 1954.) 1s.

Report and Accounts of the National Botanic Gardens of South
Africa for the year ending 31 December 1953. Kirstenbosch, New-
lands, Cape, and The Karoo Garden, Worcester. Pp. 20. (Kirsten-
bosch: National Botanic Gardens, 1954.)

Durban Museum Novitates. Vol. 4, Part 4: Miscellaneous Taxono-
mic Notes on African Birds. By P. A. Clancey. Pp. 77-90. (Durban
Durban Museum and Art Gallery, 1954.) 2s. 6d.

International Council of Scientific Unions. Mixed Commission on
the Ionosphere. Proceedings of the Third Meeting held in Canberra
(Australia), from August 24th to 26th, 1952. Pp. 194. (Bruxelles:
General Secretariat of the International Council of Scientific Unions,
1953.)

Kementarian Perhubungan. Djawatan Meteorologi dan Geofisik
Verhandelingen No. 45. Upper Winds Over Indonesia and Western
New Guinea. By Dr. F. H. Schmidt. Pp. 100+24 charts. Meteorolo-
gical and Geophysical Service. Ministry of Communications.
Observations made at Djakarta. Vol. LX B. 1937-1940—Magnetic
Observations. By Dr. F. H. Schmidt. Pp. 116. (Djakarta: Kepala
Djawatan Meteorologi dan Geofisik, 1952.)

Tanganyika. Annual Report of the Geological Survey Department,
1952. Pp. ii+40. (Dar-es-Salaam: Government Printer, 1953.)
2/50 Shs.

East African High Commission. Filariasis Research. Annual Report
1952. Pp. 40. East African Medical Survey. Annual Report 1952.
Pp. iv+107. (Nairobi: East African High Commission, 1953.)

Forest Research Institute, Dehra Dun. Indian Forest Leaflet No.
121 (Part 3), (Entomology): A Systematic Catalogue of the Main
Identified Entomological Collection at the Forest Research Institute,
Dehra Dun. Parts 2-21: Orders Isoptera, Embioptera, Psocoptera,
Anoplura, Hymenoptera, Odonata, Thysanoptera and Hemiptera.
By M. L. Roewer, R. N. Mathur, G. D. Bhandari, Balwant Singh, G. D.
Pant, Avinash Chandra, K. N. Kalyar and R. K. Mathur. Pp. ii+39-
168. (Delhi: Manager of Publications, 1953.) 4 rupees; 6s. 6d.

Indian Forest Bulletin No. 108 (New Series): Wood Preservation
Wood Preservation in India (Past, Present and Future). By J. N.
Pande and Y. G. Jadhav. Pp. v+74+10 plates. (Delhi: Manager of
Publications, 1953.) 3 rupees, 8 annas; 6s. 6d.

Queensland Institute of Medical Research. Eighth Annual Report
of the Council for the year ended 30th June, 1953. Pp. 14. (Brisbane:
Government Printer, 1953.)

Contributions to American Anthropology and History. (Publication
506) Vol. 11, Nos. 52-56. No. 52: Geologic Observation on the
Ancient Human Footprints near Managua, Nicaragua. By Howell
Williams. No. 53: Mound B-III-3, Kamallajun Guatemala. By
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Copan, with notes on Courts at La Union, Quirigua, San Pedro Pinala
and Amecoba. By Gustav Stromvik. No. 56: Pottery from
Cupoc, Alta Verapaz, Guatemala. By Robert H. Smith. Pp. vi+236
(Washington, D.C.: Carnegie Institution of Washington, 1952.)
6.75 dollars, paper bound; 7.50 dollars, cloth bound.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Royal Institute of Chemistry. Lectures, Monographs and Reports,
1954. No. 1. The Development of Radiation Chemistry and Radio-
chemistry. By Sir John Cockcroft, F.R.S. (Eighteenth Dalton Lecture)
Pp. ii+12. (London: Royal Institute of Chemistry, 1954.) 25s.
The Agricultural History Review. Vol. 1—1953. Pp. 64. (Annual
subscription 21s.) (Reading: British Agricultural History Society,
1954.)

Flora of Tropical East Africa: Turneraceae. Edited by Dr. W. B.
Turrill and B. Milne-Redhead. Pp. 20. (London: Crown Agents for
the Colonies, 1954.) 1s. 8d.

Colonial Office. Fishery Publications, No. 5, 1954: Fertilisers in
Fishponds. By Dr. O. H. Mortimer. With additional material and a
foreword by Dr. C. F. Hocking. Pp. iv+156. (London: H.M.
Stationery Office, 1954.) 25s. net.

Ministry of Agriculture and Fisheries. Technical Bulletin No. 4.
The Calculation of Irrigation Need. Pp. vi+38. (London: H.M.
Stationery Office, 1954.) 2s. net.

Siemens Brothers and Co. Ltd. Engineering Bulletin No. 206/70,
February/May, 1953. Plymouth "B" Power Station. Pp. 12. (London:
Siemens Brothers and Co. Ltd., 1954.)

Philosophical Transactions of the Royal Society of London. Series
B. Biological Sciences. No. 649, Vol. 237, 17 February 1954. A
Biometrical Study of *Alternaria commutans* and *A. (Isaria) crateri*
serotina. By K. A. Kermack. Pp. 375-428. 16s. (No. 650, Vol.
237, 17 February 1954: British Hypogeous Fungi. By Lillian R.
Hawker. Pp. 429-646. 27s. (London: Cambridge University Press,
1954.)

Construction of Esso Refinery, Fawley: a Study in Organization.
By A. P. Gray and Mark Abrams. Pp. 40. (London: British Institute
of Management, 1954.) 3s. 6d.

The National University of Ireland. Calendar for the year 1953.
Pp. 468. (Dublin: National University of Ireland, 1953.)

Iodine Information. No. 38. Iodic Acid and the Iodated. Pharma-
cology and Therapeutic Applications. Pp. 50. No. 39: Endemic
Goitre. Practical Notes on Cause and Prevention. Pp. 12. No. 40:
Stability of Iodine Compounds for Animal Nutrition. Pp. 12. No.
41: Preventive and Curative Medicine. Some Applications of Iodine.
Pp. 8. (London: Chilean Iodine Educational Bureau, 1953 and
1954.)

Royal Technical College, Glasgow. Report on Research. Session
1952-1953. Pp. 40. (Glasgow: Royal Technical College, 1954.) 5s.
Carnegie United Kingdom Trust. Fortieth Annual Report, 1952.
Pp. viii+36. (Dunfermline: Carnegie United Kingdom Trust,
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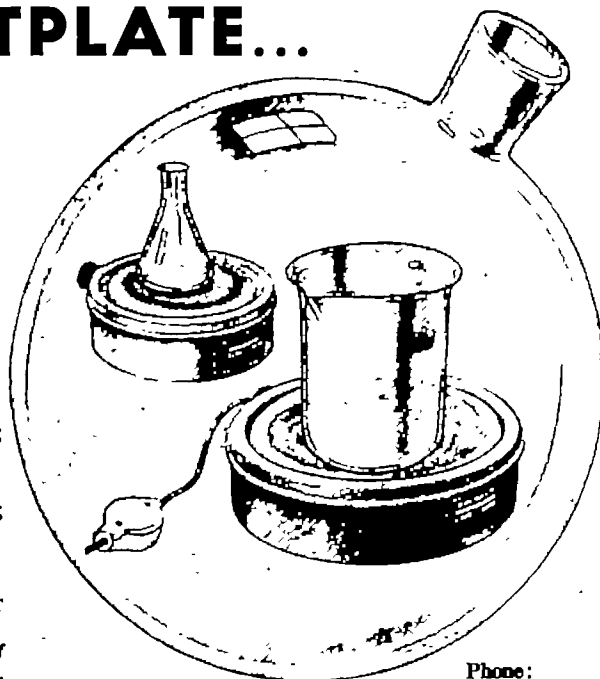
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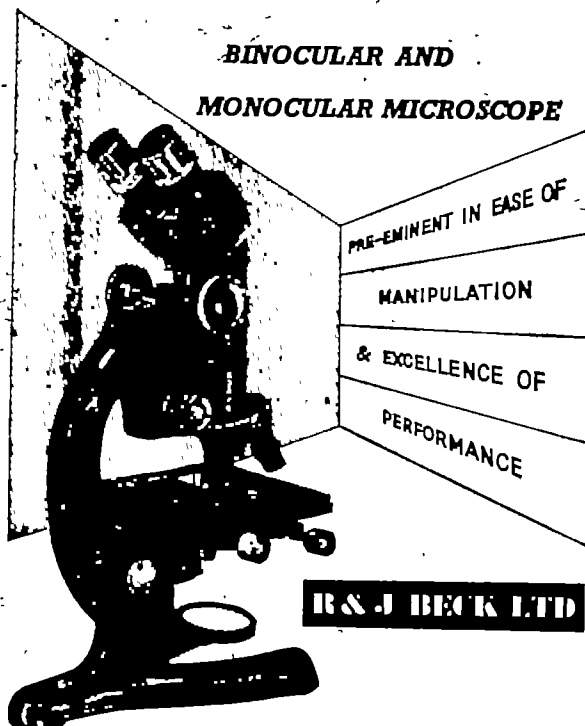
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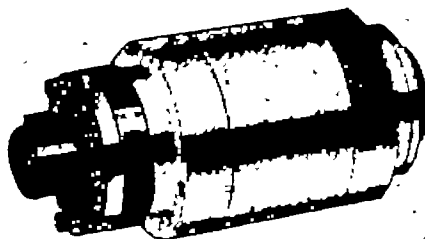
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DEFENCE RESEARCH AND THE NATIONAL ECONOMY

DR. O. H. WANSBROUGH-JONES, chief scientist in the Ministry of Supply, stated in a lecture to the Royal Society of Arts last year that the relation between the scientist and the Armed Services in Great Britain is satisfactory, and scientific advice is being rendered normally and effectively up to the highest levels. Concern, as expressed in the recent debates on defence in Parliament and elsewhere, is rather with the other aspect of defence research—its cost and the disposition of our available resources between defence research and civilian research. Even when full allowance is made for the great value to British industry and to science, to which Dr. Wansbrough-Jones testified, of much of the scientific research and development carried out on behalf of the Services, the level of that expenditure provokes the question whether it is not already too high.

The "Statement on Defence, 1954"* puts the expenditure of Britain on defence research and development in 1954-55 at nearly £160 million, or, according to the Prime Minister, about double that in 1951-52. No analysis of the distribution of this research effort between the different Services or Ministries is attempted in the analysed defence budget, although the distribution of the total expenditure on production and research is shown. Only general comments are made on the complicated character of new weapons coming into use and the need for developing entirely new techniques before successful laboratory experiments issue in practical weapons for the Armed Services. The time required for the various stages of research, development and production tends to increase, and the weapons themselves are extremely and progressively expensive.

These are the factors which have prompted the suggestion that even now we are spending too little on research and development, and which make so difficult the decision how best to divide available funds between improvements—and possibly major improvements—in current weapons and equipment, and research and development on new weapons. As to the nature of the new developments, the Statement says little. Good progress has been made with the development of a fighter aircraft the speed of which well exceeds that of sound, and a research aircraft of this type is expected to fly within the next twelve months. The new fighters now being introduced into the Royal Air Force will in due course be equipped with powerful air-to-air guided weapons which will perhaps quadruple their fighting power. Good progress is being made in the development of surface-to-air guided weapons, and these developments are being supported by continual improvements in arrangements for detecting incoming enemy aircraft and in the control and reporting system generally. In land warfare, the effects of research and development policy are to improve the efficiency of the ground forces rather than to make

it possible to reduce numerical strength. At sea, the introduction of the steam catapult and angled deck has made possible the operation of aircraft of much higher performance from aircraft-carriers. These developments, together with the great improvements in methods of anti-submarine detection and in naval weapons generally, will greatly increase the ability of the Royal Navy to carry out its main function of controlling sea communications.

It is obvious that the Statement on Defence contains far too little information to permit informed public discussion of defence policy and of the soundness of the actual compromises on which the Government has decided. As Lord Alexander of Hillsborough pointed out, the ordinary citizen can form no idea where these defence expenditures will lead us. To some extent this is inevitable; but something could well have been said, within the limits of security, to indicate why there is no mention of the replacement programme by new construction which a year ago the First Lord of the Admiralty said is vital if the Royal Navy is to exist as a balanced and efficient fighting force. Enough was said in the debates in Parliament to show the wisdom of giving the nation the fullest possible reasoned statement, at least where a fundamental change in the traditional role of one of the Fighting Services is contemplated. There should be no secrecy for secrecy's sake.

Quite apart from the concern which has been provoked by the explosion of the hydrogen bomb since the defence debates began, and the probable need for a revision of the priorities laid down in the Statement on Defence, the Government should go to the limit in taking the public into its confidence in this matter of defence development and research. When the Select Committee on Estimates reviewed the national expenditure on research and development in 1947, the Defence Research Policy Committee had only just been constituted. Annual reports from such a Committee are not to be expected; but little, if anything, has since been published to show that the weaknesses relating to defence research and development revealed by the inquiry have been removed. The position in regard to atomic energy had, of course, been transformed before the Atomic Energy Corporation Bill was presented to Parliament; but in insisting that, if it is to discharge its duty, Parliament needs to be provided periodically with 'progress reports' setting out the range, aims and progress of Government research activities, the Select Committee made no exception for defence. The very magnitude of the increase in expenditure on defence research and development is a further reason for implementing its strong recommendation that those estimates should be reviewed independently at more or less regular intervals. At seven years such a review is overdue.

This is not the inquiry for which Lord Alexander of Hillsborough pressed in the debate on the Statement on Defence in the House of Lords on March 16. That was rather for an inquiry into defence policy and its formulation, which, as Lord Swinton rightly observed, is one of the most important functions of the Government and a duty which no Government could

* Statement on Defence, 1954. Pp. 26. (Cmd. 9075.) (London: H.M. Stationery Office, 1954.) 1s.

possibly devolve on anyone else. Even an inquiry which would dispel misgivings apparent in the debate as to the balance of expenditure on man-power and on production, research and development might go too far in that direction.

In any event, substantial support was forthcoming in the House of Lords debate for the view that the balance is about right. Lord Alexander of Tunis, the Minister of Defence, remarked that the next three or four years would see the completion of many of the major projects towards which our research and development programme has been directed for some years; he referred also to the indispensable co-operation of Australia in our weapon research and development, and pointed out that, while in 1950 about one-third of our total defence expenditure went on production, research and development, in 1954, out of a total expenditure nearly twice as great, almost half was on production and defence research. With an expenditure which has thus almost trebled in four years, it is only reasonable that Parliament should have at least such assurance as the Select Committee on Estimates could give that all possible sources of duplication of effort or waste of resources have been eliminated, the weaknesses indicated by the earlier inquiry removed and that no departmental prejudices or conservatism are giving rise in the fresh circumstances to new sources of inefficiency or waste.

The Minister of Defence spoke wisely of the need for making full use of our imagination in dealing with the difficult problems now confronting us without losing sight of present realities and needs, and of the importance of a forward-looking policy in making the best use of the defence resources of Britain in an era of scientific progress. This more limited inquiry, however, could have its part in steadying public opinion and engendering confidence as to the balance of our effort not only in the field of defence but also between our defence effort and that in other fields. This is especially true of research and development, where any serious distortion can well retard progress both in the field of defence and that of industrial and economic development. Moreover, as Lord Hore-Belisha insisted, a defence programme on a purely national basis is anachronistic. He believes that within the Atlantic Treaty Organization there is room for much closer cohesion to prevent overlap in research and the production of weapons.

Since the debates on the Statement on Defence, further information regarding the hydrogen bomb explosions have given point to this criticism. Assurances have been forthcoming from scientists and from the chairman of the United States Atomic Energy Commission that the tests are not beyond control or limitation. It seems clear, too, that they have strengthened President Eisenhower's argument for a greater sharing of knowledge between the United States and Britain and her other partners in the defence of the free world.

While, however, from the point of view of advancing knowledge, the hydrogen bomb and like experiments are necessary and are being carried on with due

regard to all reasonable safeguards, both legal and scientific, it may still be asked whether we have not in fact reached, or approximated to, the point of no return. The purpose of continued experiment is to prevent any potential enemy of the free world from gaining a completely decisive lead. It may be argued that atomic weapons have already reached a stage at which it is meaningless to speak of a decisive lead. Here it needs to be remembered again that the limited resources of Britain do not permit us to provide our Armed Forces with all those things which they would wish to have. The Minister of Defence, too, stressed the limitations of our resources and, bearing in mind what Dr. Wansbrough-Jones said about the efficiency of our system, it is most unlikely that any tests have been or will be made beyond those essential to the design of reliable and manageable weapons. The tests are extremely costly and laborious, and those responsible for carrying them out are acutely aware of the pressure for financial economies, which is just as strong in the United States as in Britain.

There is every reason for scientists to do what they can to urge the freer exchange of information on atomic energy and the reduction of the area of secrecy regarding defence research and development to the narrowest limits consistent with security. Responsible public discussion of these questions by them could do something to help steady public opinion, and to make clear that so far as atomic weapons are concerned the only alternative to developing a sufficient supply of effective weapons of this type as deterrents is, not to refuse to have anything to do with them, but to secure an agreed acceptance of effective control. To outlaw the atomic or the hydrogen bomb is meaningless without a system of enforced law, the first condition of which is the clear knowledge of facts which only a constant and vigilant inspection in every country could supply.

Such a system the United States and Great Britain and other members of the United Nations, except only the U.S.S.R. and its satellite States, have consistently been prepared to accept. President Eisenhower has since made his offer for the pooling of supplies of uranium, thorium and other materials in the hope of providing a new means to agreement and understanding, and possibly later to full international control of atomic energy. Until, however, the abatement of suspicion permits the adoption of an agreed system of prohibition in which both sides have full confidence, it would be folly not to strive to ensure that at least equal striking power remains in the hands of the less secretive and less aggressive side. The Statement on Defence and debates in Britain show clearly how large is the responsibility of statesmen for securing the political conditions in which, if not disarmament, at least the sharing of information, research and production could lighten the burden of defence on individual nations. It is no less clear how much depends also on the scientist, in order that the resources made available for defence may be used most efficiently and to the greatest advantage, not merely of the Armed Forces but also of the national economy as a whole.

CIRCULATION IN THE NORTH ATLANTIC OCEAN

By HENRY STOMMEL

Woods Hole Oceanographic Institution, Massachusetts

SIXTEEN years ago there appeared in *Nature*¹ an announcement of plans for a five-year co-operative programme for the study of the circulation in the North Atlantic Ocean.

The first part of this programme, to be performed by the *Atlantis*, research vessel of the Woods Hole Oceanographic Institution, was to make periodical hydrographic traverses across the Gulf Stream from Montauk Point on the North American coast to Bermuda. From measurements of temperature and salinity, made in a vertical section of the ocean, it is possible to construct the field of density; by virtue of the laws of hydrostatics, the pressure field may then be computed. As in the atmosphere, large-scale horizontal pressure gradients in the ocean are largely balanced by Coriolis forces associated with components of the velocity field normal to them. Oceanographers make frequent use of this so-called 'geostrophic approximation' to calculate the velocity field from the density field because of the great difficulty of making direct current measurements in the sea. It was hoped that frequent hydrographic sections would reveal seasonal fluctuations in the transport of the Gulf Stream system—all of which passes between the North American mainland and Bermuda.

The second part of this programme was to be carried on from the Bermuda Biological Station, using a small vessel provided by a grant of the Royal Society. Because of the peculiar location of the Island of Bermuda, at the centre of the North Atlantic circulation, it was hoped that frequent measurements of the vertical density structure near the Island could be correlated with the transport fluctuations of the Gulf Stream. Should this prove

to be the case, such simple local measurements might eventually be of the very greatest importance for European meteorology and for fisheries hydrography. In any event, it was felt that this phenomenon ought to be explored. It was also proposed that this small vessel, based at Bermuda, should undertake a programme of measurement of wind-drift currents, in order to check the Ekman wind-drift current theory.

Within a year these plans were hopelessly disrupted by the Second World War. However, Iselin² was able to publish in 1940 a preliminary study of thirteen *Atlantis* sections made up to that time. Of course, the number of these sections is very small for the purpose of analysis for periods. Moreover, there are gaps in the series: two sections are available for 1937; five during May–October 1938; and six during May 1939–January 1940. With the latter exception, there are no winter-time observations, a fact which was inevitable because of the relatively small size of the *Atlantis*. Iselin showed what may be interpreted as a seasonal variation in the transport of the Gulf Stream, the most pronounced feature of which is a distinct minimum during October–November. This seasonal variation was supported by tide gauge observations obtained at Charleston and Miami (it is to be expected that changes in the field of density in the ocean will be accompanied by changes in the mean elevation of the sea surface); therefore, it seemed likely that the transport of the Gulf Stream varies seasonally from a minimum transport of at most 76 million, to a maximum of at least 98 million, cubic metres per second.

During the war years, no study of the Gulf Stream system was made. However, an instrument of great practical importance, the bathythermograph, was

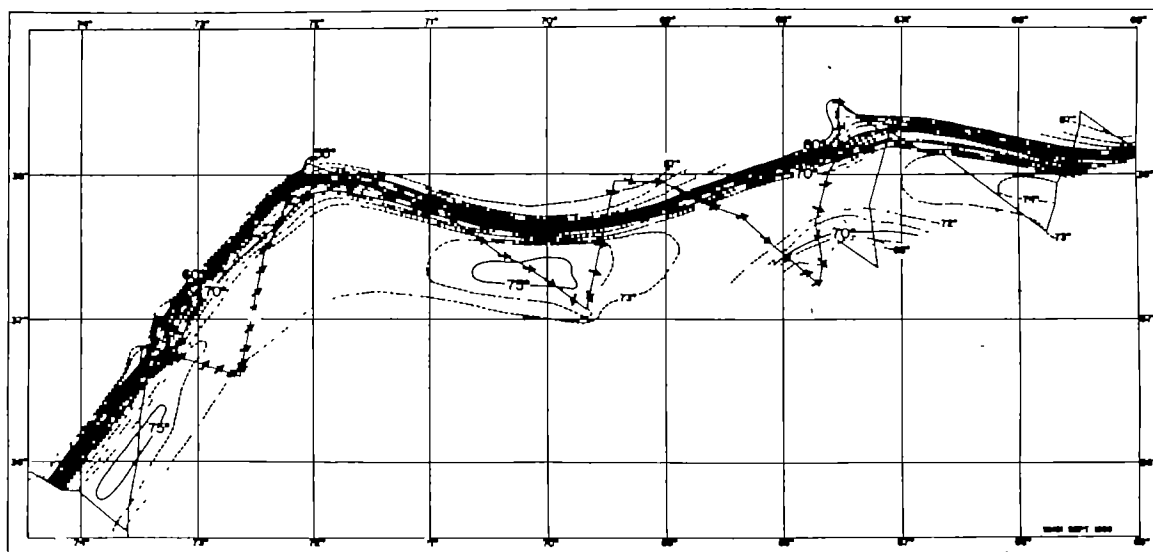


Fig. 1. Fugister and Worthington's chart of the mean temperature (°F.) in the upper 200 metres of the Gulf Stream on June 8, 1950, showing the meander-pattern. The solid zig-zag line is the ship's track. The small arrows show the direction of flow (but not speed) as indicated by towed electrodes. The very large horizontal gradient of temperature shown by the crowding of isotherms is along the left side of the Stream. The main body of the Gulf Stream is limited to a band extending not more than 1° of latitude to the south of these intense thermal gradients. In the course of two weeks this meander-pattern was observed to progress about one-half wave-length to the east.

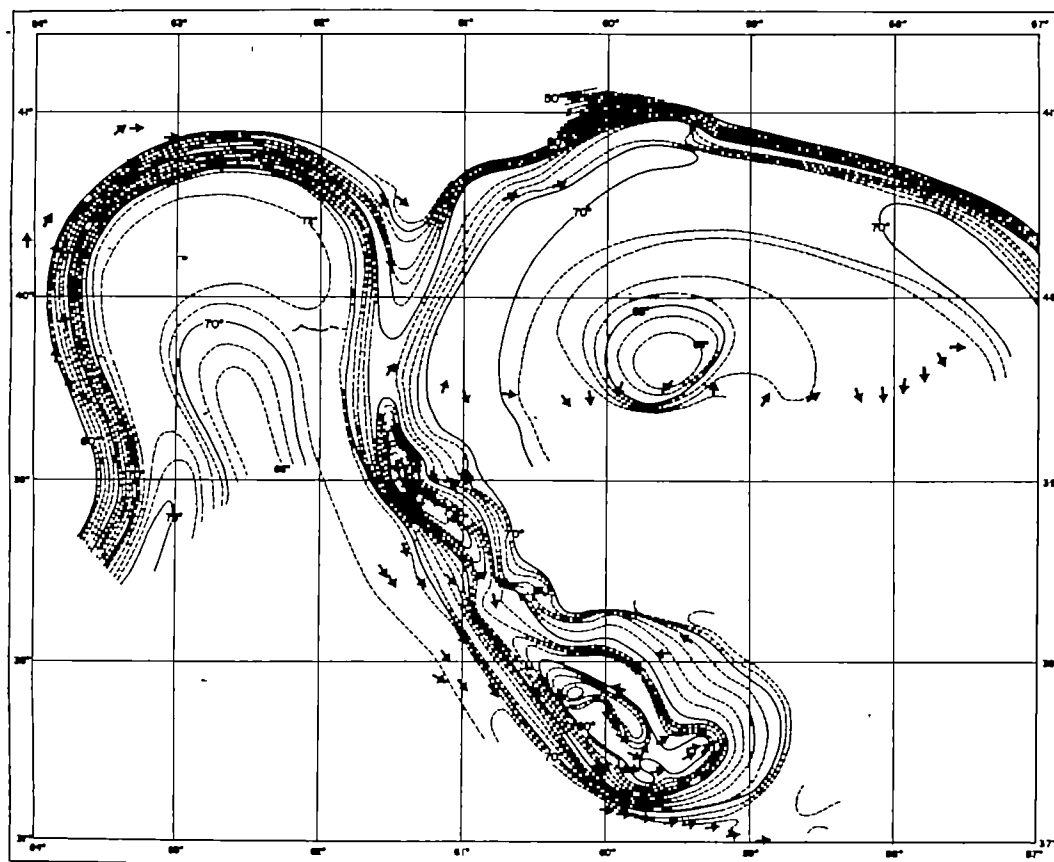


Fig. 2. Mean temperature ($^{\circ}\text{F.}$) of the upper 200 m. layer on June 17, 1950. Current arrows from the 'G.H.E.'. Confirmation to the east of the meanders shown in Fig. 1. It portrays one stage in the development of the unstable breaking up of a meander-pattern in which a large mass of cold northern water is becoming isolated in the warmer surface waters to the south of the Gulf Stream.

devised for the rapid measurement of temperature as a function of depth (900 ft. is the practical maximum depth, at present) from a ship under way. In the North Atlantic Ocean, 210,000 bathythermograph soundings have now accumulated. This useful instrument has also revealed extraordinary horizontal eddy and meander formations along the Gulf Stream, complications which were not previously expected, and which throw some doubt on the validity of the 'geostrophic approximation' for transport calculations because of the small radius of curvature exhibited by some of these features. It therefore seemed possible that the Gulf Stream traverses made by Iselin might have been through meanders, and that the resulting errors in computed transports could have been as large as the variations he attributed to seasonal influences. More recent evidence (referred to later), however, supports Iselin's original interpretation despite the uncertainty of the location of the *Atlantic* traverses relative to meanders. Although it would be very desirable to evaluate directly the various terms in the dynamical equations for even a single meander, by measuring density and velocity over a small network of stations at intervals of a day for a period of several weeks, such a programme is quite beyond the resources of oceanographical science at present.

The exploration of meander-patterns reached a high point in the multiple-ship survey of 1950³, during which seven vessels of the U.S. and Canadian Navies, as well as research institutions, were engaged for more than two weeks in producing a synoptic

chart of a segment of the Gulf Stream eight hundred miles long. The chief result of this effort was to show the existence of a series of horizontal wave patterns beginning at Cape Hatteras and extending downstream to long. 65° W., with a wave-length of approximately 200 km., and a downstream phase-velocity of 11 miles a day (the water in the centre of the Stream moves with a particle velocity of 100 miles a day). At long. 61° W., a meander-wave of excessive amplitude was observed as it developed into a detached eddy of cold water in the warmer water on the offshore side of the Stream. The growth of this single large eddy is interesting because it is the only direct observational evidence of large-scale lateral mixing processes so often postulated in theoretical studies of the dynamics of oceanic circulation.

The introduction of towed electrodes⁴ has proved very useful in such synoptic surveys; although a way for deducing the total transport of the Stream from towed electrode measurements is known on theoretical grounds, it has not yet proved possible to do so for practical reasons. The great practical advantage of towed electrodes is that they provide an instantaneous estimate of surface current from a ship under way; thus the oceanographer knows at every moment which way to direct his vessel to stay with the Stream or to cross it.

Another instrument, the airborne radiation thermometer, has made possible the rapid aerial mapping of meander-patterns by means of their surface temperature. Used from a low-flying aeroplane, this

instrument consists of an infra-red detector which is exposed alternately to the radiation from the sea surface and that from a reference body within the aeroplane. The temperature of the reference body is adjusted so as to produce the same signal upon the detector as does the sea surface; their temperatures thereupon are nearly equal. The inshore edge of the Gulf Stream has been traced all the way from Miami to south of the Grand Banks by this means, in the space of two days.

In the years immediately following the Second World War, there was also a reawakened interest in theoretical study of general oceanic circulation. In a study of the detailed weak horizontal flow patterns in central oceanic areas (excluding strong currents like the Gulf Stream), Sverdrup discovered that they could be accounted for as a balance between the tendency for water moving along meridians to take on a relative vorticity about the local vertical, and the curl of the local wind stress. In another study, Stommel discovered that the east-west asymmetry of oceanic circulations could be explained in terms of the variation of the Coriolis parameter with latitude. In 1950 Munk¹ published an elegant synthesis of these studies in which he was able to deduce the main features of the horizontal transport in the ocean from the actual distribution of the wind stress. Briefly stated in qualitative terms, Munk's theory asserts that the stationary mean-vorticity field of the North Atlantic surface circulation is maintained by a balance of three processes tending to change the vorticity at any point: (1) the local curl of the mean wind stress, (2) the change of relative vorticity due to north-south components of motion (variable Coriolis parameter), and (3) lateral diffusion of vorticity by macro-turbulence. Over most of the North Atlantic the curl of the mean wind stress has the same sign, and since horizontal velocity gradients are too small to make process (3) important, process (2) must provide the necessary balance, and the meridional component of transport hence of same sign (southward). Conservation of mass requires provision for this water to be returned northward; the mathematical solution of the vorticity equation provides such a northward flow in an intense narrow high-velocity 'boundary layer' along the western coast of the ocean where processes (2) and (3) completely dominate process (1). This theoretical concept of a western 'boundary layer' corresponds to the Gulf Stream system. Comparison of the amounts of water transported by such a theoretical Gulf Stream with those measured is encouraging. The chief difficulty in reconciling this theory with the actual Gulf Stream is to discover lateral mixing processes in the Stream sufficient to transfer the vorticity required. Except in the large eddies at long. 61° W., the water in the Stream seems remarkably immiscible with its environment.

Tide gauge observations have gradually been accumulated from gauges recently established at Cat Cay, Havana, and Bermuda, a basic source of information which was largely unavailable from these places before the War. In addition, we have new techniques for measuring quantities indicating the strength of the North Atlantic circulation: since August 1952, measurements of electrical potential difference across the Florida Straits have been regularly made on a submarine cable between Key West and Havana. When the tidal components and the short-period variations due to magnetic storms have been eliminated, there remains a potential

difference produced by electromagnetic induction of the sea water moving through the earth's magnetic field, which is proportional to the total transport of water through the Florida Straits. A preliminary analysis of these measurements has confirmed the seasonal variation described by Iselin, and has also revealed very rapid short-period fluctuations in the transport of water of the Florida current—as much as twofold in ten days. At present these latter fluctuations defy explanation.

Within the past year, an Oceanographic Observatory has been established by the Woods Hole Oceanographic Institution at the Bermuda Biological Station for the purpose of making synoptic studies of the north-western Sargasso Sea. Hourly measurements of wind-drift currents in the shallow surface layers are now being made regularly, using wireless telemetering buoys. Resistance thermometers are being installed permanently on a submarine cable to a depth of 1,600 fathoms, in order that a continuous long-term record of the thermal structure in this critical portion of the North Atlantic can be obtained. This Observatory is the first attempt on the part of oceanographers to obtain continuous day-by-day records from the deep ocean.

It may be expected that in the years to come long-term measuring programmes, such as this Bermuda thermometric cable, will play an increasing part in oceanography. They are certainly much more economical than ships.

In conclusion, it should be evident that despite the fact that the complexity of the ocean circulation is considerably greater than supposed sixteen years ago, the number of techniques of observation has increased correspondingly, and there is no reason to despair of achieving an understanding of the North Atlantic circulation.

¹ Iselin, C. O'D., *Nature*, 141, 772 (1938).

² Iselin, C. O'D., *Pap. Phys. Oceanogr. Meteor.* (Cambridge and Woods Hole, Mass.), 8, No. 1, 1 (1940).

³ Fuglister, F. C., and Worthington, L. V., *Tellus*, 3, No. 1, 1 (1951).

⁴ von Arx, W. S., *Pap. Phys. Oceanogr. Meteor.* (Cambridge and Woods Hole, Mass.), 11, No. 3, 1 (1950).

⁵ Munk, W. H., *J. Meteor.*, 7, No. 2, 79 (1950).

STRUCTURE OF OPTICALLY ACTIVE COMPOUNDS IN THE SOLID STATE*

By PROF. J. M. BIJVOET
University of Utrecht

IN the great successes of X-ray analysis that determined structures as complicated as those of sterols and alkaloids and that now ambitiously approach the domain of Nature's most complicated biochemical compounds, the proteins, the central problem of X-ray analysis, namely, the location of the atoms in the crystal, was solved by Fourier methods.

As early as 1915, Sir William Bragg introduced the underlying conception of the crystal¹. Instead of the atomic positions, the electron density all over the crystal is considered, in which distribution the atoms finally reveal themselves. This periodic electron distribution may be developed in a Fourier series, that is, it may be seen as a homogeneous background that is modulated by the superposition of density

* Substance of a course of three lectures delivered in the University of London on March 15, 17 and 19.

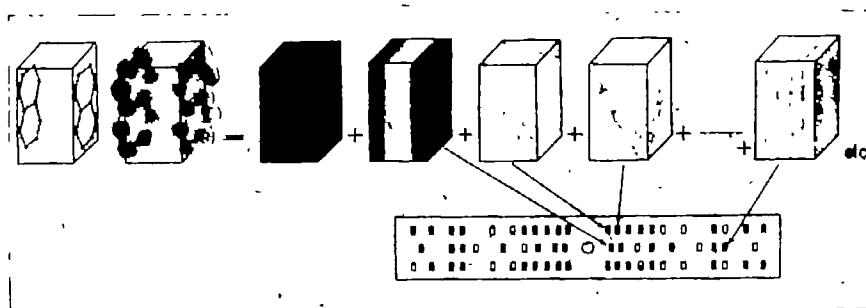


Fig. 1. Relation between density waves and X-ray diagram

waves. As these waves must satisfy the periodicity of the crystal, the Fourier development is restricted to a discrete series.

Each density wave causes a reflexion spot on the X-ray diagram, which consequently gives us information about the wave (see Fig. 1). This close relation between X-ray diagram and density waves makes this conception of the crystal eminently useful in X-ray analysis. The position of the diffraction spot gives us the orientation and period of the density wave; its intensity gives the amplitude. The phase of a density wave—that is, the distance of its maximum from the origin of the cell—is lost in the X-ray diagram, however, direction as well as intensity of the reflexion being insensitive to a parallel shift of the reflecting wave front. This lack of information about the phase prohibits the direct synthesis of the Fourier waves, which otherwise would immediately reveal the atomic arrangement from the X-ray diagram. The determination of the phases of the density waves thus constitutes the central problem in the Fourier method of X-ray analysis.

The crystal can be described in either of two ways: by the position of the atoms, or by its Fourier waves. Nature gives us part of either description: the atoms that are present, but not their co-ordinates; she gives the density waves, but not their phases. The problem is to translate either of these complementary sets of data into the language of the other description, thus attaining a description which is complete.

The method that starts on the basis of Fourier waves owes its prevalence to the fact that in Fourier synthesis general methods could be devised for determining phases systematically.

We propose to consider here the heavy-atom technique of phase determination in the form of the isomorphous substitution method. In this method two isomorphous crystals are used. These derivatives have exactly the same crystal structure except for the substitution of one of the atoms by a heavier atom of approximately the same size. From the resulting changes in intensity the unknown phases can be derived. In particular, I propose to extend the common scheme of this method to the non-centrosymmetrical case. Obviously in this case the location of the density waves is more difficult than when a centre is present, since a centre, by reason of symmetry, from the very onset restricts the

possible locations to the extreme cases of maximum or minimum in the origin (centre).

The complete determination of the phases in the non-centrosymmetrical case implies the solution of the old problem of the determination of the absolute configuration of optically active compounds, a problem which chemistry studying the mutual behaviour of compounds cannot solve.

Let us outline the procedure of the isomorphous substitution method in this general case. Though the structure of the crystal is not known, the configuration of the heavy atom, which strongly influences the intensities, can easily be determined by a special procedure, the Patterson synthesis, and we shall consider it here as known. By the isomorphous substitution an extra electron density corresponding to the latter configuration is introduced. We shall call this known density the 'test density', because it will be used to test the location of the component waves. Added to the light compound, it yields the density of the heavy compound (see Fig. 2, left-hand column). If we represent each of these three electron densities by its Fourier waves, the sum relation will also hold for every set of the component Fourier waves (Fig. 2). It is this additivity relation which permits the determination of the phase angles—though only in absolute value. For in each set the test wave is known in amplitude and phase, whereas the amplitudes alone of the other two terms are known from the X-ray diagrams. In the addition process, only the correct phase of the light-compound wave will yield the observed amplitude of the heavy-compound wave. The unknown phases can thus be calculated from the three known amplitudes.

It is interesting to note that this problem ofatching phase differences by turning them into amplitude differences is by no means restricted to X-ray analysis. It also turns up in, for example, microscopy. When the object is perfectly trans-

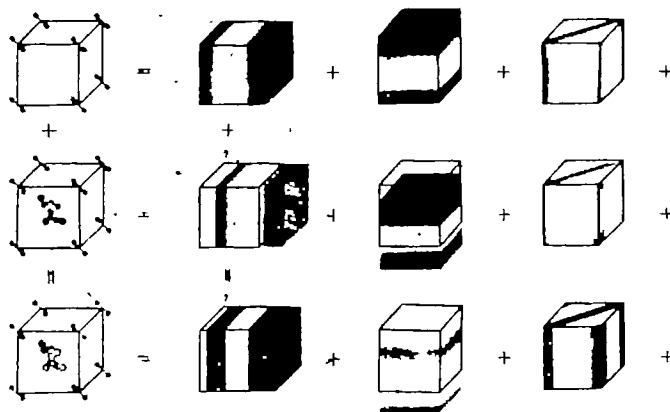


Fig. 2. Additivity relation between electron densities of light- and heavy-atom compounds and their Fourier waves respectively

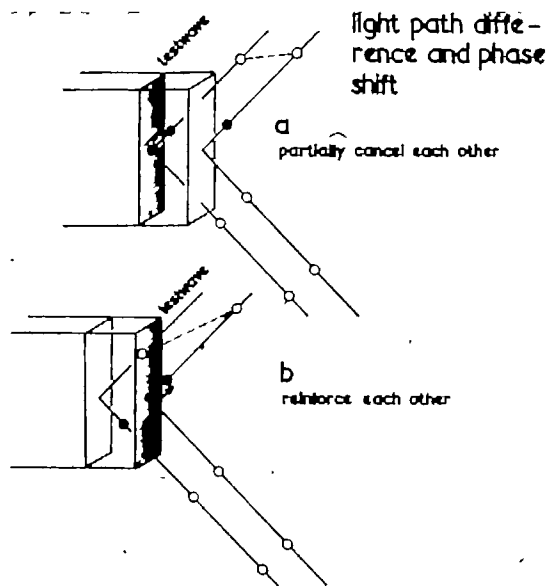


Fig. 3. Determination of phase sign by anomalous scattering

parent, there are only phase differences in the image, which consequently cannot be seen. In intercepting the undeviated light, a constant vector is subtracted in every point of the image, and vectors of different amplitude result.

The amplitude or intensity comparison of light and heavy compound upon which phase determination is based is widely used in the centrosymmetrical case. Since the famous example of phthalocyanine³, a number of centrosymmetrical projections of complicated compounds have been determined along these lines. It is fortunate for the easy applicability of the method that most biochemical substances crystallize in space groups with a two-fold axis, so that we have at least one centrosymmetrical projection. For the non-centrosymmetrical projections the determination of the phase angle obviously needs more accurate intensity data, but careful intensity measurements appear to give the phase angles with sufficient accuracy, as has been proved in the cases of strychnine hydrosulphate/selenate³ and glycyltyrosine hydrochloride/bromide⁴. However, in the location of the waves, a last and rather serious difficulty still remains. When we determine the relative location of the Fourier wave and the test wave, it remains undecided whether the Fourier wave at the required distance is on one side or on the other side of the test wave (see Fig. 3). It is the *sign* of the phase angle that is unknown and still prevents the direct synthesis. So we find ourselves confronted with the problem of the determination of sign of the phase angle, a rather puzzling problem that has no counterpart in the centrosymmetrical case. This problem can be solved by a trick⁵.

We take a Fourier wave *A* of the heavy atom configuration and the corresponding wave *B* of the rest of the crystal. For ordinary X-rays it is the path difference only between *A* and *B* which causes the phase differences between their diffracted beams, and $\varphi_B - \varphi_A = (\varphi_B - \varphi_A)_{\text{path}}$.

This is equal—though of opposite sign—in our two cases (Fig. 3) and as a consequence these cases cannot be distinguished, as the resulting intensities are equal.

If, however, we use X-rays of special wave-length, which just excite the heavy atoms, the X-rays will be absorbed as well as scattered by this atom in an anomalous way. It is this anomalous scattering which is made use of in distinguishing the two cases of Fig. 3.

All electrons scatter like free electrons if the frequency of the incident radiation is large compared with their own frequency. The strongly bound K-electrons of the heavy atoms, on the other hand, oscillate and scatter with phase opposite to that of the free electrons. Going from hard to soft X-rays, the K-electrons change their behaviour in the region where the frequency of the incident radiation approaches the proper frequencies of these K-electrons: the phase changes gradually when approaching the absorption limit.

Under these conditions:

$$\varphi_B - \varphi_A = (\varphi_B - \varphi_A)_{\text{path}} + (\varphi_B - \varphi_A)_{\text{primary scattering}}$$

in which only the first term on the right-hand side changes sign for the two situations of Fig. 3. The total difference is seen to take different values, which enables us to distinguish the two situations. The influence of anomalous scattering on the reflexion intensity of a density wave thus makes the determination of the sign of its phase angle possible.

In our microscope example, the different phases in the image were turned into different amplitudes by the interception of the undeviated light. However, phases which are mutually opposite in respect to the intercepted component in this optical case also remain indistinguishable. In the phase-contrast microscope⁶, this is remedied by imparting to this component an abnormal phase change instead of intercepting it.

Thus the phase problem in X-ray analysis, that is, the determination of phase angles also in sign, is solved. Theoretically, Fourier synthesis is then straightforward also in the non-centrosymmetrical case, and this synthesis gives the antipode in its absolute configuration since the inversed image has opposite phase-angle signs.

The chart opposite summarizes the whole procedure for different cases of complexity. In the direct synthesis of non-centrosymmetrical structures, there is a gap between what is theoretically possible and what has actually been achieved hitherto. The note of interrogation indicating this gap refers to practical difficulties. It has not yet been thoroughly investigated whether the small effect of the anomalous scattering will be measurable for a sufficient part of the reflexions involved in a complete Fourier synthesis. There is every appearance, however, that the increasing accuracy of the measuring technique will indeed enable us to realize this programme.

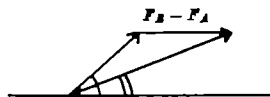
An alternative method, which lacks the straightforwardness of the direct method, consists of the determination of the combination of relative phase signs and the subsequent absolute determination of a single one of them.

In the first part of this procedure, which has been followed for strychnine hydrosulphate/selenate and glycyltyrosine hydrochloride/bromide, a Fourier synthesis is made with the double number of waves, both signs of the phase angle being used simultaneously. This double Fourier will give the super-

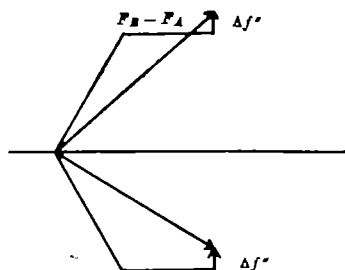
PHASE DETERMINATION IN THE ISOMORPHOUS SUBSTITUTION METHOD

Centre of Symmetry
(determination of amplitude sign)
Heavy atom on centre (a) Location of the heavy atom (Patterson analysis) (1936)
Heavy atom out of centre (b) Algebraic amplitude addition (1939)

No centre of symmetry
(determination of phase angle)
(a) Location of the heavy atom.
(b) Determination of absolute value of phase angle from amplitude addition in vector diagram (1949).



(c) Synthesis of double Fourier and resolution by geometrical considerations.
(d) Phase shift by anomalous scattering (1980).
Determination of absolute configuration (1961).
(e) Determination of all phase signs by anomalous scattering (1971).



position of the two antipodes, as the right set of signs results in the actual structure of the opposite set in the inverted structure. These two structures must be separated by geometrical considerations, which require the interatomic distances to be of normal value. These spatial considerations deprive the method of much of its simplicity and beauty; the atoms no longer 'emerge' quite spontaneously from the X-ray data which is so striking in direct Fourier synthesis. It is therefore obvious that along these lines no discrimination is reached between the two disentangled structures. The double Fourier was used for the first time under somewhat different conditions in the structure determination of cholesterol hydride⁷, and later on, in the form just described, in the cases of strychnine sulphate/selenate and glycyltyrosine hydrochloride/bromide.

The second part of the procedure consists of the decision between the two models after the structure has been found, except for possible inversion. This determination of absolute configuration has been carried out for a compound basic⁸ in stereochemistry: for tartaric acid, in the form of the sodium rubidium double salt⁹ and the acid rubidium salt¹⁰.

Anomalous scattering of the rubidium atoms was obtained by the use of x-ray rays. Although the phase sign of one density wave would have been sufficient, the effect was observed for several reflexions. The phase signs of the salts of dextro-rotatory tartaric acid fitted the conventional model, which consequently was proved to correspond to its real configuration.

As early as 1930, Coster proved the III and III' reflexions of zinc sulphide are of unequal intensities for rays exciting the zinc atom. This determination of the sense of a sequence is exactly the problem we met with in the location of our reference wave and the Fourier wave of our crystal. In both cases it is the sense of a polar sequence which must be determined, and indeed can be determined by anomalous diffraction.

The method for determining absolute configuration supplies organic chemistry with a means of establishing the configurational relation between compounds which cannot be converted into each other, or in the conversion of which a Walden inversion may take place that changes the configuration into its mirror image. Investigations in this field are in progress in several laboratories.

It is surprising that, although the structure effect in zinc sulphide was known, the determination of absolute configuration was still thought for many years to be impossible.

¹ Bragg, W. H., *Phil. Trans. Roy. Soc., A*, 215, 253 (1915).

² Robertson, J., *J. Chem. Soc.*, 615 (1935); 1195 (1936).

³ Bokhoven, O., Schoone, J. O., and Bijvoet, J. M., *Acta Cryst.*, 4, 275 (1961).

⁴ Smith, D. W., and Wilebenga, H. H., *Acta Cryst.*, 6, 531 (1953).

⁵ von Laue, M., *Ann. Physik*, 50, 33 (1916). Coster, D., Knol, K. S., and Prins, J., *Z. Phys.*, 63, 345 (1930). See also James, R. W., "The Optical Principles of the Diffraction of X-rays", Chapter 4 (1948).

⁶ Zernike, F., *Physica*, 1, 690 (1934).

⁷ Carls, O. H., and Crowfoot, D., *Proc. Roy. Soc., A*, 184, 64 (1945).

⁸ As regards the historical role of tartaric acid in stereochemistry, see Bernal, J. D., "Science and Industry in the Nineteenth Century", Chapter 7 (Boutledge and Kegan Paul, London).

⁹ Bijvoet, J. M., Peerdeman, A. F., and van Bommel, A. J., *Nature*, 163, 271 (1951). Peerdeman, A. F., van Bommel, A. J., and Bijvoet, J. M., *Proc. Roy. Soc., Amsterdam*, B, 54, 16 (1951).

¹⁰ van Bommel, A. J., *Proc. Roy. Soc., Amsterdam*, B, 56, 268 (1953).

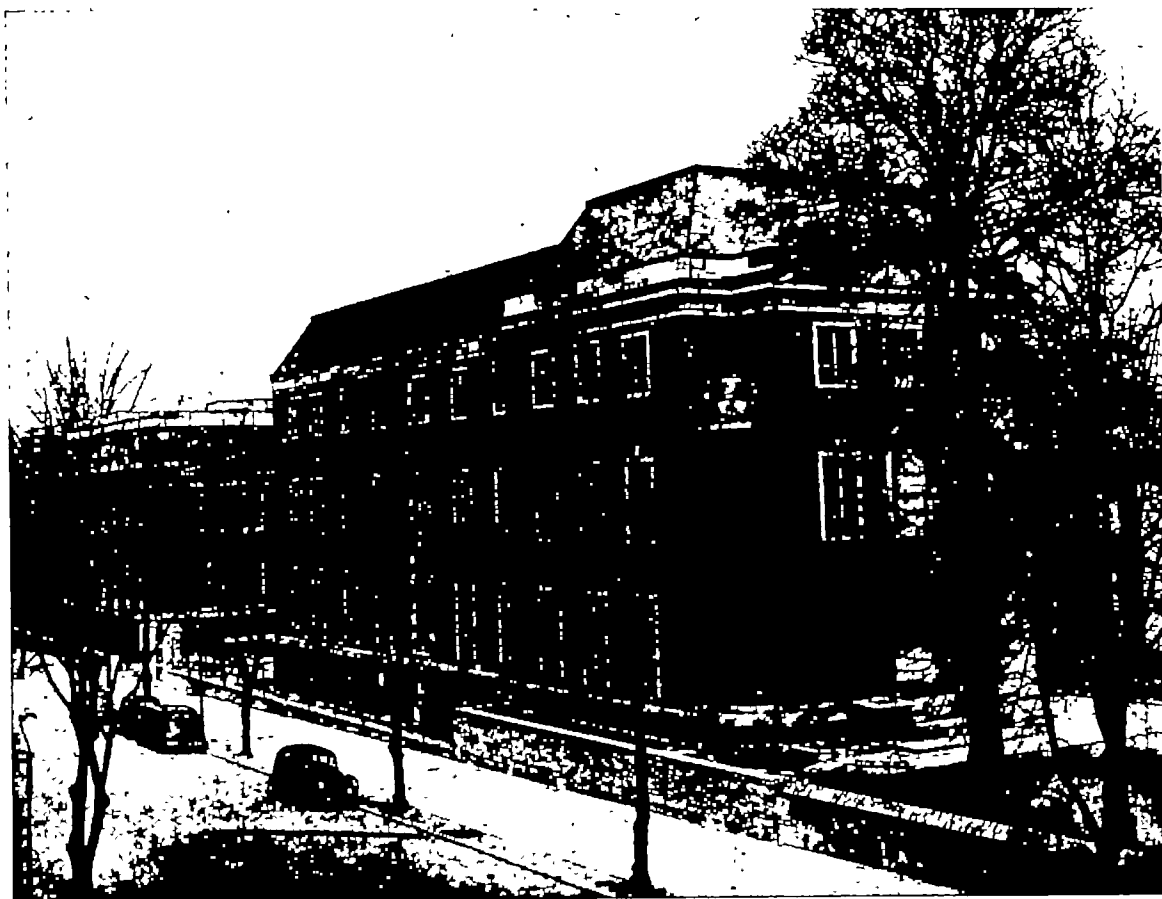
THE QUEEN'S UNIVERSITY,
BELFAST

NEW GEOLOGY BUILDING

WHEN Queen's College, Belfast, was founded in 1847, Frederick McCoy was appointed to the chair of geology and mineralogy. In 1854 McCoy left Belfast for Australia, where he continued to build up his world reputation as a palaeontologist and was eventually knighted. Wyville-Thompson, who succeeded him, became professor of natural history in 1860 on the amalgamation of his own Department with the Departments of Zoology and Botany. After Wyville-Thompson went to Edinburgh in 1870 and until 1909, geology continued to be taught in the combined Department. With the foundation of The Queen's University in 1909, chairs of zoology and botany and a lectureship in geology were created, Dr. A. R. Derryhouse being elected to the new lectureship. On his resignation in 1921, the chair of geology was re-established, and Dr. J. K. Charlesworth was appointed.

In the days of Queen's College, geology shared a common museum and lecture room. Since 1921 the Department has occupied a succession of wooden buildings, at first two army huts, later the orthopaedic and later still some of the general wards of the Ulster Volunteer Force Hospital erected in the grounds of the University in 1915. Plans were prepared in the 1930's for a new geology building, with Mr. John McGeagh as architect and Mr. (now Sir) Edward Maufe, R.A., as consultant. The outbreak of war in 1939 and the subsequent shortage of materials postponed the erection of the building until September 1950 and its completion until this year. The formal opening by Sir Edward Bailey took place on April 30.

The geology building forms the south-west wing of a group of buildings to be arranged around a large quadrangle opening to the south on to Elmwood Avenue. Hence the entrance to the geology building



The Queen's University, Belfast. New geology building

Belfast News-Letter

is on the north at one end of a future cloister. The exterior has been designed on clean contemporary lines and has regard for the adjacent agricultural building of Georgian style and for the traditional styles of the University district. The chief materials are Buckley Junction hand-made sand-faced bricks, Oliphame stone and green Borrowdale slates.

The building, rectangular in plan, is about 124 ft. long and 41-44 ft. wide. It has three floors, an attic, and a basement or lower ground floor. The latter, which is excavated beneath the whole site except the lecture theatre, is occupied by women's and men's cloak rooms and lavatories; by a boiler house with solid fuel fed by automatic stoking thermally controlled, and designed ultimately to heat half the buildings around the new quadrangle; by an unpacking room which receives large consignments of rocks or apparatus by a ramp from the gate leading to the agricultural court; and by a rock-cutting room the ceiling of which is cork-insulated to eliminate vibration and sound from the rest of the building. A full-sized lift carries the loads to each floor, including the attic.

On the ground floor are the entrance vestibule, senior laboratory, attendant's room, demonstration lobby, lecture theatre and professor's rooms; on the first floor the elementary laboratory, map room and library, and photographic rooms; and on the second floor the large petrology and palaeontology laboratories, chemical laboratory and small lecture room. Staff and research rooms occur on each floor. The undivided attic, which extends beneath a mansard

roof over one-third of the building, is well lit by circular dome lights of glass in the flat part of the roof and is ventilated by clerestory windows. It provides the research and store space of the future.

The lecture theatre, which seats 160, has mechanical ventilation, electrically operated blinds, dimming roof lights, and a large lecture bench. Uninterrupted views are obtained of the bench, blackboards, coloured geological models, maps and projection screen. The demonstration lobby, on the line of approach to the lecture theatre, serves for the display of photographs, maps and specimens to illustrate lectures and at the same time gives added spaciousness to the entrance hall. The two supporting rectangular columns have been used for depicting the geological column in its chronological, palaeontological, petrological and tectonic aspects.

The corridors, which are 8 ft. wide to provide viewing space for the numerous coloured maps, have been reduced to a minimum by placing the lecture theatre, large laboratories and library and map room at the ends of the building. The laboratories are lined along their outside walls with show-cases which fit flush under the windows and rest on drawers. In this way, a separate museum is avoided, all the material in the Department forms part of the teaching collections, and space is provided for new accessions which are immediately available for study: store-rooms as such become unnecessary. The wall cases have dictated the method of heating throughout the building, which is by low-pressure hot-water panels embedded in the ceilings. J. K. CHARLESWORTH

OBITUARY

Dr. E. M. Crowther

AGRICULTURAL science and particularly soil science have suffered a grievous loss in the sudden death of Edward Mortimer Crowther on March 17 at the comparatively early age of fifty-six.

Born near York on April 15, 1897, he was educated at Archbishop Holgate's School, York, and the University of Leeds, where he read chemistry, specializing in agricultural chemistry in his last year. In 1917 he joined the staff of Rothamsted Experimental Station, and ten years later, when he was only thirty, Sir John Russell, who was then director, recognizing his outstanding ability, made him head of the Chemistry Department, a position he occupied until his death. In 1950 he became one of the two deputy directors of the Station.

Crowther's early work was chiefly on the physics and physical chemistry of soils, and he published a series of important papers on methods of mechanical analysis and on soil reaction. His main interest, however, throughout a very active career, was soil fertility and crop nutrition. While maintaining the great tradition of Lawes and Gilbert, he added to their thoroughness the exactitude of modern methods of field experimentation. Recognizing at once the value of the statistical work of R. A. Fisher and F. Yates on experimental design, he became the pioneer of its application to field experiments in agriculture and forestry, and his influence was felt and his advice sought in many parts of the world.

He became one of the greatest authorities on the use of fertilizers, and as a result of his work, major improvements were made in the manuring of various crops, notably sugar beet, potatoes and flax. He demonstrated conclusively, for example, the manurial value of salt for sugar beet, a matter of importance particularly during the war-time scarcity of potash. His work also threw fresh light on methods of soil analysis, and he used field experiments for improving and calibrating these methods. For many years he had been giving attention to the problems of phosphatic fertilizers, including the immobilization of water-soluble phosphate in soil, and latterly he had been employing radiotracer techniques. This work was a good illustration of his method of using the results of field experiments for developing new lines of work in the laboratory, which in their turn reacted on his field approach. During the Second World War, in collaboration with the Building Research Station, he was actively engaged in the development of a silicophosphate fertilizer, and more recently he had been engaged in assessing the value of this and other new phosphatic fertilizers which are being developed to economize in the use of sulphuric acid. His interest in fertilizers, however, did not cause him to neglect organic manures, and he did much work on farmyard manure, sewage sludge, composts and green manuring, endeavouring to assess their manurial value and long-term effects.

During the War he was deeply involved in questions of fertilizer policy. There were difficult decisions to be taken regarding the use of shipping for the importation of fertilizers or food, and the problems of using the limited quantities of fertilizers in those parts of Great Britain which needed them most. With F. Yates he made a survey and critical analysis of all fertilizer experiments in Great Britain and other northern European countries, and the success-

ful rationing policy was largely the application of his work and of his unrivalled knowledge of crop nutrition. He rightly advocated the use of much greater amounts of nitrogen, and the rapid increase in food production was in no small measure due to this. The Ministry of Agriculture frequently sought his advice and made use of his services on many of its committees.

In recent years Crowther became keenly interested in the manuring of forest nurseries and in the rehabilitation by means of 'partial sterilization' of some of the old nurseries which had ceased to raise useful conifer seedlings. He showed that, in general, properly balanced fertilizers are as effective as composts for this purpose, and revolutionized the manuring practice in the Forestry Commission's nurseries.

Crowther's interests were by no means confined to British agriculture. He travelled widely, visiting many parts of Europe, America, Africa, India and Malaya, and those of us who accompanied him on some of these journeys will always recall his tireless energy, his penetrating observation, and his breadth of outlook. It was natural that his early interest in soil classification and particularly in the relation between soil and climate should be intensified by these travels.

Most of his work in the tropics, however, was connected with soil fertility problems, and he planned and supervised many manurial experiments on cotton, oil palm and rubber. He had a special interest in the Sudan, where he collaborated with his brother, the late Dr. Frank Crowther, and he served for many years on the Sudan Government London Advisory Committee and on the Research Advisory Committee of the Empire Cotton Growing Corporation. The Colonial Office made much use of his wide knowledge, and he was a valued member of the Committee for Colonial Agricultural and Animal Health and Forestry Research.

His capacity for blending academic research with the investigation of practical problems is well illustrated in his publications, the wide range of subjects of which indicate the variety of his interests. He was one of the editors of the *Journal of Agricultural Science* and the *Empire Journal of Experimental Agriculture*, and was active in many scientific societies, including the International Society of Soil Science. In 1951 he was president of Section M (Agriculture) of the British Association, and in 1952 and 1953 of the British Society of Soil Science and the Fertilizer Society. Both as a writer and speaker he was lucid and effective, and he completed the Jubilee Memorial Lectures of the Society of Chemical Industry only a few days before he died.

Among the qualities associated with Crowther in the memory of those who were privileged to know him, his sincerity, integrity and kindness stand out. The most loyal of colleagues, he would take great trouble to advise and assist the serious worker, however junior; but he had a keen critical faculty and was not slow to expose what was superficial and slipshod. In him, world agronomy has lost one of its foremost workers, and the deep personal affection and professional esteem in which he was widely held have been strikingly shown by the messages received since his death.

He married Miss Elizabeth Dorothy Kay in 1924, and she and their son survive him.

W. G. Ogg

NEWS and VIEWS

Agricultural Botany at Reading:

Prof. W. B. Brierley

PROF. WILLIAM B. BRIERLEY, who retires from the chair of agricultural botany in the University of Reading in September, was educated at the University of Manchester and in 1912 was appointed to the staff of the Department of Botany there. In 1916 he went to Kew as joint head of the newly established Pathological Laboratory, and in 1918 to Rothamsted as the first head of the Department of Plant Pathology which, during his period, developed from a small, bare room into a notable centre of plant disease research. In 1932 he succeeded Prof. John Percival at Reading. His personal investigations have been in the fields of phytopathology and microbiology, where his interests and guiding influence have made themselves felt throughout the world: his paper on an albino *Botrytis* in the *Transactions of the Royal Society* is a classic. In Reading he has built up an honours school in the sciences that together constitute the field of agricultural botany, which has sent research workers and teachers to all parts of the world. For a quarter of a century Brierley was honorary editor of the *Annals of Applied Biology*, a task which he carried out with unremitting care and scientific integrity. He is an honorary member of the Association of Applied Biologists and a freeman of the American Phytopathological Society. A welcome visitor to European and American centres of botanical research, and a prolific correspondent, his contacts in many lands have given him a world-wide reputation in the field of applied botany.

Prof. D. W. Goodall

DR. DAVID W. GOODALL, reader in botany in the University College of the Gold Coast, who succeeds Prof. Brierley, graduated at the Imperial College of Science and Technology, London, and worked for some years under Prof. F. G. Gregory on problems of plant development and nutrition. In collaboration with Prof. Gregory he published a valuable book on the chemical composition of plants as an index of their nutritional status. For two years he was in the Colonial Agricultural Service, seconded to the West African Cocoa Research Institute, where he worked on physiological problems in the cacao plant. In 1948 he was appointed senior lecturer in botany in the University of Melbourne, where he became especially interested in statistical ecology, and he has developed this interest further in relation to the classification of types of tropical vegetation since his return to the Gold Coast.

National Research Council of Canada:

Mr. B. G. Ballard, O.B.E.

MR. B. G. BALLARD, director of the Division of Radio and Electrical Engineering of the National Research Council of Canada, has been appointed to the additional post of vice-president (scientific), in succession to Dr. E. W. R. Steacie, the present president of the Council (see *Nature*, 169, 1049; 1952). Mr. Ballard graduated in 1924 from Queen's University, Kingston, Ontario, and afterwards was on the Westinghouse staff for five years working on the development of railway electrification. He was appointed to the Division of Physics of the National Research Council in 1930, and during the following ten years he gradually built up the Electrical

Engineering Section. This work became extremely important during the Second World War, when Mr. Ballard's efforts included the development of mine-sweepers and other means of protecting ships against enemy magnetic mines. The equipment was used on both coasts as well as on the high seas, and his work was recognized by the award of the O.B.E. In 1946 the Electrical Engineering Section was amalgamated with the Radio Branch of the Division of Physics and Electrical Engineering, and Mr. Ballard was made assistant director of the Division. With the subsequent expansion of work a separate Division of Radio and Electrical Engineering was established in 1948, and Mr. Ballard was appointed its director. In 1949 he was awarded the Ross Medal of the Engineering Institute of Canada for a publication called "Recent Canadian Radar".

Sir Jack Drummond Memorial Fund

THOUGH the raising of funds for a fellowship in memory of the late Sir Jack Drummond has not yet been terminated, sufficient money has already been accumulated for an award to be made available as from October 1. The fellowship will be worth £900 a year, tenable in the first instance for one year, and will be for research on nutrition, with special emphasis on human nutrition, to be conducted in, or in association with, a university department or research institute of similar standing. The award may be made to a comparatively young scientific worker provided he has reached a stage at which he can undertake independent work. Further information can be obtained from Dr. B. Ifor Evans, Provost of University College, Gower Street, London, W.C.1.

New Building for the Radio Research Station

ON May 10, Dr. R. L. Smith-Rose, director of radio research in the Department of Scientific and Industrial Research, cut the first sod on the site of a new building being erected at the Radio Research Station, Ditton Park, Slough. This occasion marks another step in the Department's post-war plan for a considerable extension in the programme of research conducted under the advice of the Radio Research Board. The site is in the grounds of the Admiralty Compass Observatory at Ditton Park, where nearly 100 acres have been available for field experimental work for many years past. In addition, the Ministry of Works has purchased another 100 acres of the neighbouring farm. This additional land has been acquired mainly to ensure that the whole site is kept free from undesirable electrical interference with the radio research work. A very small portion of it may be used for further experimental work; but apart from this, the additional land will continue to be available to the farmer. The building has been designed by the architects of the Ministry of Works specifically to meet the requirements of the Radio Research Station. A two-story administrative block together with the workshops, stores, dining-room and all general services are concentrated at one end of the building. The scientific and technical laboratories are contained in a single-story building with a main block and four spurs, the ends of which open directly on to the field, which is regarded, for radio experiments, as a continuation of the laboratory working-space. Every effort is being made to restrict the metalwork installed in the field so that the minimum of disturbance is caused to experimental work. In order to reduce to the minimum the radio interference from the ignition systems of motor traffic,

the building site is more than 200 yards from the nearest road; and most of the working parts of the fields in use are nearly half a mile from any public road carrying vehicular traffic. In cases where the research work is of a type that cannot be conducted inside the building, provision is made for the use of a number of huts of a temporary and transportable nature. The present staff of the Radio Research Station, all in temporary accommodation, is just over a hundred, and it is expected that this will be considerably increased when the new building is ready for occupation.

Metallic Corrosion: an Instructional Film

A 16-mm. coloured film entitled "Corrosion in Action", originally made in the United States under the auspices of the International Nickel Company, Inc., is now available in Britain and can be borrowed for educational or other purposes from the Mond Nickel Company, Ltd. (Thames House, Millbank, London, S.W.1). The film, which lasts for sixty-four minutes, has to a certain extent been edited for British consumption, the main change being a new sound-track with an English-accent commentary. Each topic begins from first principles but rapidly builds up to intermediate and even degree level. The economic importance of the general corrosion of metals is first explained, and then a short historical survey leads to a diagrammatic explanation of electro-chemical corrosion, oxygen being emphasized as a promoter of cathodic reactions. The arrangements of metals in their electromotive series introduce a discussion of galvanic action in terms of potentials, current density and area effects, and this is shown in a series of laboratory tests utilizing colour-changing reagents which detect the existence of anodic and cathodic corrosion products. Passivity and protective films are demonstrated by a series of bench experiments, indicating how important the film can be in some instances. Local shielding and the damage resulting from it are followed by a section comparing the mechanism of corrosion of various materials. The film ends with illustrations of the measures that can be taken to minimize corrosion and the importance of choosing materials in the light of the full knowledge of the many factors in individual corrosion problems.

Agricultural History Review

WITHIN a year of its inauguration, the British Agricultural History Society has issued the first volume of its official publication, the *Agricultural History Review*. The Society was founded to bring together those interested in agriculture as a living, historical process, whether their sphere of activity lay in academic institutions or in the countryside. The new publication should do much to promote this aim, and its appearance is timely in view of the rapid changes that have been taking place in rural life and practice during the mid-twentieth century. Each issue will contain a number of articles embodying original research in agricultural history, together with shorter notes and comments, a bibliography and book reviews. The following titles of the articles in the first number, each of which is contributed by a well-known specialist, give some idea of the scope of the publication and the potential wealth of suitable subject-matter: some traditional farming beliefs in the light of modern science; the poll tax and census of sheep, 1549; the Isle of Axholme before Vermuyden; agricultural returns and the government

during the Napoleonic Wars; a Cornish farmer in Ontario, 1830-71. The *Review* is issued only to members of the Society (c/o Museum of English Rural Life, 7 Shinfield Road, Reading; 1 guinea a year). The first number contains sixty-four pages, and at least two issues annually are anticipated.

Bird Study

As in every other science, progress in ornithology is very dependent upon publication. This point is well brought out by Major-General H. P. W. Hutson, chairman of the British Trust for Ornithology, in the foreword to a new journal which has recently been launched by the Trust (*Bird Study*, 1, No. 1; March 1954). The first issue contains an article by J. F. Monk on the breeding of the greenfinch and another by D. Lack describing observations made on robin populations in Oxford and south Devon. The Rev. P. H. T. Hartley has contributed a stimulating and unusual article on back-garden ornithology which should be most encouraging to would-be bird observers. The journal also contains a section illustrating recent activities of the British Trust for Ornithology. The production of this journal is of good standard, although one misses the attractive photographs which have become a marked feature of other bird journals.

Institution of Mining and Metallurgy: Awards

THE Institution of Mining and Metallurgy has recently made the following awards: *Gold Medal of the Institution*, to Mr. Essington Lewis, president of the Fifth Empire Mining and Metallurgical Congress, in recognition of his long and distinguished services to the mining and metallurgical industries of Australia; *The Consolidated Gold Fields of South Africa, Limited, Gold Medal*, to Dr. J. S. Webb, for his work on the development of geochemical prospecting methods; *The Consolidated Gold Fields of South Africa, Limited, Premium of Forty Guineas*, to Mr. R. Daniel, for his paper on diamond mining practice in Kimberley, South Africa (*Trans.*, 62); *Arthur Cloude Student's Prize*, to Mr. T. A. Henderson, for his part authorship of the paper on some exploratory experiments on the formation and control of magnetite during copper smelting operations (*Trans.*, 62); *William Frocheville Student's Prize*, to Mr. C. L. Hall, for his part authorship of the paper on laboratory tests on the concentration of witherite from the northern Pennines by froth flotation (*Trans.*, 62). Honorary membership of the Institution has been conferred on Mr. Thomas Pryor, past-president of the Institution, in recognition of his services to the Institution and to mining education.

Nuclear Physics Conference in Glasgow

AN international conference on experimental and theoretical nuclear physics will be held in the Department of Natural Philosophy of the University of Glasgow during July 12-17, under the general chairmanship of Prof. P. I. Dee. This conference is sponsored by the International Union of Pure and Applied Physics and the United Nations Educational, Scientific and Cultural Organization, and is one of similar conferences on various topics which are held each year in a country of the United Nations Organization. It is fitting that Glasgow should be chosen as the meeting place, as this year has seen the opening of the new Nuclear Physics Building, housing, among other apparatus, the largest synchrotron in Europe. There will be about three

hundred delegates to the conference, representing twenty-six different countries. During the conference lectures will be given on the outstanding problems of nuclear science, with particular reference to the part played by mesons in nuclear forces, and it is hoped that the interchange of information and ideas between physicists from different parts of the world will result in some of these problems being solved. Further information can be obtained from the secretary of the conference, Dr. K. G. McNeill, Department of Natural Philosophy, University, Glasgow, W.2.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: G. W. Anderson (agricultural officer, Zanzibar), agricultural officer, Uganda; R. N. Coster (agricultural officer, Fiji), agricultural officer, Sierra Leone; M. Luman (agricultural officer, Tanganyika), regional assistant director of agriculture, Tanganyika; R. K. Tremlett (agricultural officer, Uganda), agricultural officer, Zanzibar; N. Kirby (deputy government chemist, Jamaica), government chemist, Jamaica; E. W. March (conservator of forests, Jamaica), conservator of forests, Nigeria; J. D. Arneed (medical officer, grade B, Trinidad), pathologist, grade B, Trinidad; W. R. E. Nanton (agricultural officer, Grenada), superintendent of agriculture, Windward Islands; B. C. Akhurst and H. W. Mitchell, agricultural officers, Tanganyika; J. R. Watkins, geologist, Uganda; Miss M. M. Bools, pathologist, Sierra Leone; Miss H. T. Brash, soil survey officer, Gold Coast; A. E. Green, senior British laboratory technician, Rockefeller Foundation Regional Virus Laboratory, Trinidad; D. P. Hinton, agricultural officer, Northern Rhodesia; H. W. Ord, economist/statistician, Kenya.

Announcements

PROF. B. F. J. SCHONLAND, director of the Bernard Price Institute of Geophysics and Carnegie-Price professor of geophysics in the University of the Witwatersrand, has been appointed deputy director of the Atomic Energy Research Establishment, Harwell.

DR. D. B. SPALDING, University demonstrator in engineering in the University of Cambridge, has been appointed to the University of London readership in applied heat tenable at the Imperial College of Science and Technology.

A RESEARCH scholarship worth £400 a year for two years has been offered by the Aluminium Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a committee of the Institution of Naval Architects, and it is hoped to make an award in September this year. Further particulars of entry, which closes on June 30, can be obtained from the Secretary of the Institution, 10 Upper Belgrave Street, London, S.W.1.

THE Bermuda Biological Station has recently received a grant covering a period of five years from the United States National Science Foundation. These funds, which are immediately available, will be awarded mainly as fellowships to pay for research space, living expenses or special collecting facilities required while at the Station; applications for aid in purchasing equipment or necessary travel expenses may also be considered. A booklet describing the

Bermuda Biological Station, and application forms for the fellowships, can be obtained from the director, Dr. William H. Sutcliffe, jun., Bermuda Biological Station, St. George's West, Bermuda.

THE centenary of the birth of Henri Poincaré, mathematician and philosopher, will be celebrated in Paris during May 15-17. Further ceremonies will be held in Nancy on May 22 and later in Caen. Further information can be obtained from Le Comité d'organisation du Centenaire, Amis de l'École Polytechnique, 17 rue Descartes, Paris 5^e.

THE Meteorologische Gesellschaft in Hamburg will be holding a meeting in Hamburg during October 4-6 in honour of the centenary of the birth of G. Hellmann. Papers not longer than fifteen minutes in duration will be read, and such contributions must be submitted (with a short summary) not later than July 1 to the Meteorologische Gesellschaft, Bernhard-Nocht-Strasse 76, Hamburg 4, from which further information can be obtained.

THE Institute of Chemistry of Ireland is holding a summer school in organic chemistry in University College, Dublin, during July 6-9. Four lectures will be given on the fundamentals of the subject and two lectures on each of the following: newer methods and reagents; electrophoresis; analysis; distillation; chromatography; and spectrophotometry. The fee for the course is one guinea for members of the Institute and two guineas for non-members (students 10s.). Application forms and further information can be obtained from the Secretary, Institute of Chemistry of Ireland, 18 Ely Place, Dublin.

THE Royal Institute of Chemistry is arranging a symposium on recent advances in the chemistry and industrial applications of cellulose, to be held in the University of St. Andrews during June 28-July 2. The symposium will consider three topics: chemistry of cellulose; paper and pulp; and industrial applications of cellulose and its derivatives. Further information can be obtained from the Assistant Secretary, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

A CONFERENCE on soil microbiology will be held at Purdue University during June 21-24, sponsored by the American Society of Agronomy, the Soil Science Society of America, and Purdue University. There will be major sessions on the following topics: physical properties of soils as affected by microbial activities; soil organic matter maintenance; organic matter transformations; and frontiers in soil microbiological research. Further information can be obtained from Lewis W. Erdman, Plant Industry Station, Beltsville, Maryland.

FORTY years ago the first paper dealing with oxide-coated cathodes was published, and to celebrate this anniversary the Société Française des Ingénieurs Techniciens du Vide is organising an international convention to be held in Paris during June 24-26. The programme will be in six parts, dealing with the following topics: metal base; carbonates and coating process; emission theory of oxide-coated cathodes; definition of the cathode properties; special cathodes; and stability of emissive properties. The texts of the papers to be read will be published in a special issue of the journal *Le Vide*. Further information can be obtained from the Société Française des Ingénieurs Techniciens du Vide, 44 rue de Rennes, Paris 6^e.

THE TRAINING OF BIOLOGISTS

A DISCUSSION on the training of biologists, organized by the Institute of Biology, was held in London during April 21-22. The first session, under the chairmanship of Mr. J. F. Wolfenden, vice-chancellor of the University of Reading, was opened by Miss R. Hemmings (Girls' High School, Burton-on-Trent). She stressed the poor background from which the majority of the pupils at maintained schools come, and their ignorance, when they leave the primary schools, of any foreign language or mathematics, and of the principles of clear thinking. These deficiencies make the process of giving them a broad education both slow and difficult, and this in its turn reacts on the teaching of science. The careers which the girls follow vary widely; but teaching is not favoured. Mr. G. B. Hindle (King's Norton Grammar School for Boys) spoke of the great improvements that have taken place during the past twenty-five years in laboratories, text-books and the technique of teaching. This has been accompanied by a big increase in sixth-form numbers, and at King's Norton the use of the science sixth as a school of liberal education is encouraged. Mr. Hindle felt that professional biologists of the experimental type could be made if one started at the sixth-form level or even later, but that the training of field naturalists should begin much earlier. The shortage of qualified staff is an obvious difficulty, and while it was his opinion that pass-degree men were seldom of much use for sixth-form work, they could be helpful in the middle school.

Mr. W. H. Dowdeswell, describing conditions at Winchester College, said that biology is not begun until the sixth-form stage is reached, and this works well, at least with fairly able boys. Much emphasis is placed on field-work, about one-seventh of the total class-time being spent on this. A great handicap in making the subject live is that text-books, although so full of facts that they are difficult to read, do not treat the organisms as living creatures; they describe, for example, an abstract 'earthworm', in apparent ignorance of the fact that there are in Britain about a dozen species of different structure, habits and distribution. Mr. C. Bibby (College of St. Mark and St. John, London) balanced the wide range of initial knowledge of his students, from zero to degree standard, against the great freedom which the training colleges have to arrange their own courses.

The subsequent discussion ranged over a wide field. Points which were made by more than one speaker were that a chief duty of schools is to give a liberal education, and that many teachers keep much too closely to the syllabus and the text-book, in the mistaken belief that that is the only way to get their pupils through examinations. In answer to a question, Dr. G. E. Fogg said that the present over-production of pass-degree and third-class honours men unsuitable for teaching is not so large as had been predicted.

At the next session Dr. R. K. S. Wood (Imperial College of Science and Technology, London) gave a summary of the replies received to a questionnaire recently circulated by the Institute of Biology to heads of university departments. About two-thirds of the botany and zoology departments replied, and in nearly all there is some specialization in the final

year; but while in botany the number in which some choice is given is about the same as that in which all the special courses are compulsory, in the majority of zoology departments the student has some choice. A slight majority of the zoological heads think that this specialization ought to be reduced to a minimum; but nearly all the botanists accept it as inevitable and desirable.

Undergraduate courses in botany, plant physiology and zoology were dealt with by Dr. J. Heslop-Harrison (University College, London), Prof. F. G. Gregory (Imperial College of Science and Technology, London) and Dr. J. A. Kitching (University of Bristol), respectively. All three liked their students to have read chemistry, physics and mathematics instead of biology at school, although Prof. Gregory restricted this preference to those who would become research workers. Dr. Heslop-Harrison asked if it would not be better for future teachers and such-like to read pass degrees, so that all honours students could stay on and do postgraduate work. Prof. Gregory made a plea for the education of biological administrators—an important and increasing class. Dr. Kitching described the course at Bristol, where systematic zoology is compressed into one year and much attention is given to field-work and such special subjects as cytology and embryology.

Prof. J. F. Danielli (King's College, London) spoke on the other biological subjects and described the two ways of teaching biochemistry: as an undergraduate subject to students who have physics, chemistry and mathematics but know no biology, and as a postgraduate course for chemists or biologists. He said that the outstanding problems are the failure of the universities in general education and of the schools to attract outstanding teachers. A partial reason for the second of these was given in the subsequent discussion when Mr. D. A. Sturdy (Felsted School) said that if the universities do not want the schools to teach biology it is unlikely that the schools could attract good teachers. Prof. F. R. Winton (University of London) said that students must be allowed to study a subject when they are interested in it, a view which was applauded, and Dr. Wood that if biology were excluded from the schools there would soon be no biologists. Mr. W. B. Yapp (University of Birmingham) said that the trouble with insisting that future biologists should read chemistry, physics and mathematics in the sixth form is that the Advanced Level syllabuses in these subjects do not contain the material which they need.

The third session dealt with biology in technical colleges. Mr. S. A. Smith (London School of Hygiene and Tropical Medicine) described the courses for the examinations of the City and Guilds Institute and of the Science Technologists Association, and Dr. H. F. Steedman the special courses in biological technology which are run in the University of Glasgow. Both types of course were welcomed by speakers from the floor. Prof. I. A. Preece (Heriot-Watt College, Edinburgh) spoke on the need for a National Certificate in Biology, which would give a more theoretical qualification for such technicians as those responsible for routine testing in factories. Miss J. E. Heriot (Brighton Technical College) spoke on the difficulties and successes of technical colleges in

their degree work. In a lively discussion which followed, there was support for the idea of a National Certificate, and the difficulties in training isolated technicians, including those in schools, were stressed.

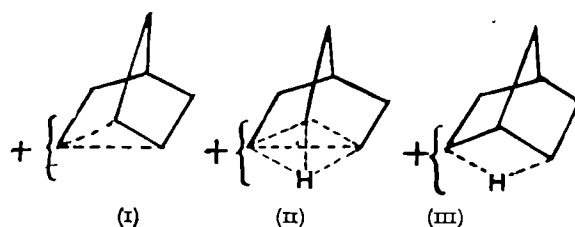
The final session dealt with postgraduate training. Summarizing the replies to the Institute's questionnaire, Dr. Wood said that few departments give any special courses in research methods, and that neither in botany nor zoology is it common for there to be concentration of the main resources of a department on a narrow field of inquiry. Dr. G. E. Fogg (University College, London) described a postgraduate course in microbiology, and Dr. G. Brownlee (King's College, London) a similar course in pharmacology. Both these consist of lectures and practical work. Prof. V. B. Wigglesworth (University of Cambridge) spoke on the Ph.D. and gave as his opinion that, in spite of its obvious disadvantages, this degree is on the whole worth while; but that employers should not insist on it. He deprecated the publication of theses, and Sir James Gray in the discussion went further and recommended their abolition. Dr. J. Y. Bogue (Imperial Chemical Industries, Ltd.) included, in his summary of the qualities which are desirable in the industrial research worker, a first-class education in the broadest sense, an ability to handle technicians and an ability to write English. The importance of the last was stressed by a number of speakers in the discussion, and other points that were made were that there might be scope for part-time postgraduate courses, and that workers who do not live in university towns are greatly handicapped by lack of library facilities. W. B. YAPP

MOLECULAR REARRANGEMENTS IN ORGANIC CHEMISTRY

ON April 6 a symposium was held by the Chemistry Department of Queen Mary College, London, on "Molecular Rearrangements in Organic Chemistry". Prof. D. H. Hey took the chair. The seven contributions covered those features of molecular rearrangements which are of current interest and stimulated a lively discussion.

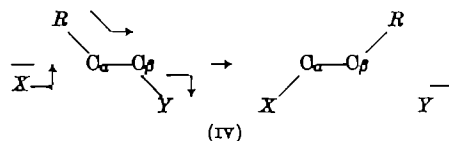
Prof. S. Winstein described his investigations of 1:3 and 1:2 hydrogen shifts in carbonium ions. Roberts and Lee¹ had established the existence of a 1:3 hydrogen shift in the non-classical norbornyl carbonium ion; Prof. Winstein has found that the hydrogen shift does not accompany formation of the ion but occurs in a subsequent step. The first ion to be formed is the non-classical structure (I), and the subsequent migration involves as intermediate either the nortricyclonium ion (II), or the alternative structure (III). Prof. Winstein favoured the latter alternative. He then described experiments in the cyclohexane series which demonstrate the possibility of anchimeric assistance of ionization by adjacent hydrogen atoms, the ionization of appropriate cyclohexyl esters occurring more rapidly than would be anticipated and with a 1:2 shift of hydrogen.

In the subsequent discussion, Dr. H. Cardwell suggested that anchimeric assistance by adjacent hydrogen might be general in *S_N1* solvolyses and pointed out that, if this were so, a statistical correction should be applied to observed solvolysis rates, depending



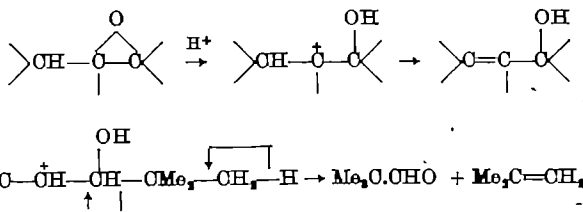
on the number of hydrogen atoms able to participate. This idea was criticized by Prof. Winstein on experimental grounds. Prof. H. C. Longuet-Higgins gave theoretical reasons in support of the structure (III) for the norbornyl intermediate. Prof. M. J. S. Dewar emphasized that, although anchimeric assistance of solvolysis implies greater stability of the π -complex form of a carbonium compound with the classical form, the converse is not necessarily true. After further discussion, the consensus of opinion seemed to be that anchimeric assistance of solvolysis by hydrogen does not occur, except in special cases, but that the π -complex ions with hydrogen in the non-classical position are probably more stable than isomeric classical structures.

Prof. O. W. Shoppee discussed the stereochemistry of Wagner rearrangements in terms of the mechanism suggested by Ingold and Shoppee². In the rearrangement (IV), inversion should occur at both carbon atoms α, β , and retention of configuration in the migrating group R. Prof. Shoppee described a number of rearrangements in the sterol series, involving migrations of groups or ring contraction, where the products obtained depend on the stereochemical configuration of the starting materials and can be predicted on the basis of the theory.



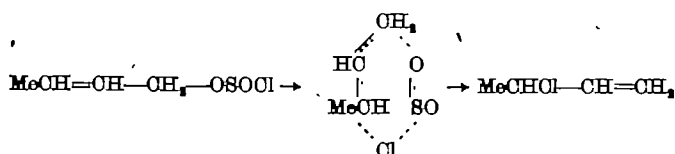
Prof. Winstein pointed out that these conclusions are somewhat too rigid; while the configuration of R is invariably retained, and while C_α and C_β commonly undergo inversion, cases are known where retention of configuration can occur. He pointed out that the stereochemical course of the reaction depends on the timing of the individual processes; in particular, exclusive inversion at C_β occurs as a rule only when there is anchimeric assistance of the ionization of X.

Dr. W. J. Hickinbottom then described a number of investigations into the course of rearrangements of epoxides and related glycols. These were interpreted in terms of the current carbonium ion mechanism. Interesting new reactions are the formation of allylic alcohols from epoxides in the presence of acid, and the fission of highly substituted epoxides and 1:2-glycols into lower ketones and olefins. These reactions were interpreted as follows:



Whether or not the rearrangements of epoxides take place via intermediate glycols is being investigated.

The second session was devoted to anionotropy. Prof. W. G. Young described the reactions of allyl alcohol derivatives with thionyl chloride. Under conditions where intervention of chloride ion is avoided, the reactions proceed with rearrangement via cyclic transition states (S_N1' mechanism), for example:



In the presence of chloride ion, an alternative S_N2 reaction leads to unrearranged chloride. By suitable choice of the reaction conditions, either unrearranged chloride, or rearranged chloride, can be obtained. An S_N1 reaction can also be observed in ionizing solvents, the product from either isomeric alcohol than being an identical mixture of the two chlorides.

Dr. E. A. Braude reviewed the historical development of the concept of anionotropy, and emphasized the role of acid catalysis. He then described a reinvestigation of the rearrangement of α -phenylallyl *p*-nitrobenzoate into cinnamyl *p*-nitrobenzoate in the presence of isotopically labelled *p*-nitrobenzoic acid in chlorobenzene solution. It was shown that the reaction occurs by two distinct paths, one involving an internal rearrangement (cf. (IV)) and one a bimolecular reaction with the added acid. Both reactions are catalysed by acid. Dr. Braude concluded that no free allylic cations are involved as intermediates, the bimolecular process being of the S_N2' type; and that free allyl cations are probably not involved in anionotropy (see also *Nature*, May 8, p. 863).

Prof. S. Winstein criticized Dr. Braude's conclusions on the grounds that free ions cannot in any event occur in the solvent used, and that the work described is consistent with the initial formation of an ion-pair, which can either rearrange by 'internal collapse' or react with *p*-nitrobenzoic acid. He thought that free ions might well participate in more polar solvents. A lively discussion followed, on the distinction between ion-pair mechanisms and mechanisms involving cyclic transition-states. The conclusion appeared to be that ion pairs and covalently bound cyclic intermediates are not qualitatively distinct, but form extremes in a graded series (cf. the relation between covalent and ionic bonds). In this case the experimental evidence does not lead to a clear distinction.

The final session dealt with rearrangements in the aromatic series. Prof. E. D. Hughes outlined a general classification of reactions in which groups migrate from the side-chain to the nucleus in an aromatic system. He concluded that the main types of mechanism are an intermolecular process of the S_N1 or S_N2' type, and an intramolecular process, giving *o*-substituted aniline derivatives via cyclic transition states. The rearrangement of *N*-phenylhydroxylamine was cited as an example of the former, and the rearrangement of *N*-nitranilines, and the reaction of aniline with sulphur trioxide, as examples of the latter.

Prof. M. J. S. Dewar outlined the various types of rearrangements that occur in aromatic systems, and

emphasized the difficulty of determining whether or not they are intramolecular. If they are, classical mechanisms will not suffice, for the rearrangements often occur between widely separated centres. He outlined the π -complex mechanism for such processes and applied the idea to the rearrangements of *N*-bromoacetanilide and of hydrazobenzene. Fresh experimental evidence was cited which suggested that the former reaction is intramolecular; and a general survey of the available evidence was held to support the mechanism in the case of hydrazobenzene derivatives. In the subsequent discussion, his conclusions concerning the mechanism of the *N*-bromoacetanilide rearrangement were strongly criticized and strongly defended.

It was generally agreed that the symposium had been of value both in presenting various points of view and in clarifying ideas. A remarkable measure of agreement was reached on most of the controversial issues.

M. F. ARNELL

M. J. S. DEWAR

¹ Roberts, J. D., and Lee, C. O., *J. Amer. Chem. Soc.*, **73**, 5009 (1951).

² Ingold, C. K., and Shoppee, C. W., *J. Chem. Soc.*, 365 (1928).

FRICITION IN RELATION TO RHEOLOGICAL PROPERTIES

ALTHOUGH a number of theories of solid friction have in the past been proposed, the one which has been most fruitful and most widely accepted in recent years is the adhesion mechanism of friction originally developed for sliding metals. According to this model, metals, when placed in contact, touch only at their high spots, and the local pressures are usually sufficient to produce plastic flow. At these regions strong adhesion occurs by a process which may be called cold welding. The strong junctions thus formed must be sheared if sliding is to occur, and this is primarily the source of the frictional resistance. With metals the deformation of the asperities is primarily plastic. Under these conditions the area of contact is proportional to the load and independent of the size of the bodies, so that the friction, too, is proportional to the load and independent of the size of the bodies (Amontons's laws).

The reality of junction formation is, shown by examining the friction tracks, which provide clear evidence of welding and shearing. This raises the interesting question as to why normal adhesion is not observed between metals. Although contaminant films may be partly responsible, the main effect appears to be due to released elastic stresses which peel the surfaces apart as the joining load is removed, so that little or no normal adhesion is detected. With soft ductile materials such as indium, where the metal can take up changes in shape of the surfaces as the load is removed, large adhesions are observed.

Clean Metals and the Influence of Oxide Films

If metal surfaces are thoroughly denuded of oxide films, Amontons's laws no longer hold. Because the surfaces are clean, they adhere strongly wherever they touch and the sliding process itself produces a very marked growth of junctions. Under favourable conditions, junction growth may proceed until the

whole of the geometric area is in intimate contact. Gross seizure occurs and ordinary sliding is almost impossible. The presence of small amounts of oxygen, however, enables sliding to occur and the friction is essentially the same as for surfaces prepared in the atmosphere.

The detailed effect of the surface oxide film depends upon the relative rheological properties of the oxide and the metal substrate. If the oxide is hard and the substrate soft, the condition is like a layer of ice on mud. Penetration takes place readily and good metallic contact occurs. The friction is high and the surface damage heavy. If, on the other hand, the oxide is ductile and can flow with the deformed underlying metal, it is better able to maintain its integrity. The friction and surface-damage may be small for moderate deformation; for sufficiently heavy deformations the surface film may be ruptured with a corresponding increase in friction and wear.

The behaviour of aluminium is of particular interest since the oxide is hard and the metallic substrate soft. Consequently, as we should expect, the thin natural oxide film offers little protection to the underlying metal. Some improvement may be obtained by artificially increasing the thickness of the oxide film by anodic oxidation. These films are, in fact, more resistant to rupture than the natural films. At small loads they maintain their integrity and the friction and surface-damage are small. With increasing load the films first fail in tension as a result of the tangential frictional forces produced during sliding. At greater loads gross disintegration of the film occurs. The frictional properties of the films depend on the surface roughness. In addition, their porosity may play an important part in trapping lubricant and so reducing the friction and wear in lubricated sliding.

Brittle Solids

The two main features of the theory of metallic friction are that cold welding occurs at the interface and that, because plastic flow takes place, the area of contact is proportional to the applied load. With brittle materials it would seem at first sight that neither of these conditions is applicable. A detailed study shows, however, that the local pressures around the individual regions of contact are sufficient to prevent brittle fracture and there is considerable plastic flow at the interface. As a result, although some surface fragmentation may occur, the behaviour is dominated by the plastic deformation of the surface layers. In addition, under the influence of high pressures and plastic flow, strong interfacial adhesion occurs. Consequently, the mechanism derived for metals is applicable; the friction is proportional to the load and of the same order of magnitude as for metals.

The high pressures existing at the points of real contact also play a very important part in boundary lubrication. The lubricant film which is sheared during sliding is subjected to pressures comparable to the yield pressure of the metal (for steel about 200,000 lb./sq. in.). Under these conditions, the resistance of the film to shear and penetration is enormously increased.

Plastics and Fibres

Other classes of materials to which the adhesion mechanism of friction may be applied are long-chain

polymers, plastics and fibres. The deformation of these materials is not, however, as clearly defined as for metals. At high loads the area of real contact is roughly proportional to the load, so that Amontons's laws are obeyed. At light loads this is no longer so. The coefficient of friction is no longer constant but increases steadily as the load is reduced. Interferometric studies show that the deformation of the surfaces is more nearly elastic than plastic. The area of contact is no longer proportional to the load, and depends on the size and shape of the specimen and on the number of points of contact. Because of this, the friction across fibres may be very different from the friction along them. If the material shows visco-elastic properties, the area of real contact at a given load will increase with the time of loading and there is a corresponding time dependency in the friction.

These and other issues relating elastic, plastic and visco-elastic properties of materials to their frictional behaviour were discussed at a symposium convened by the British Society of Rheology on February 26, on "Friction in relation to Rheological Properties". Dr. L. R. G. Treloar presided and the three main papers were given by Dr. D. Tabor, on the "Effect of Some Physical and Rheological Properties on the Friction and Lubrication of Solids", Dr. H. J. Howell on "Friction and Surface Deformation in Fibres" and Dr. F. H. R. Wright on "Frictional Behaviour of Anodic Films on Aluminium Surfaces".

D. TABOR

SCIENCE IN THE UNITED STATES

THE sixth of the annual reviews produced by the British Commonwealth Scientific Office in North America, entitled "Science in the U.S.A. for the Year ended June 1953"*, follows much the same lines as that for the year ended June 1952, which was the first to be openly published (see *Nature*, 172, 282; 1953). In its sections on the expenditure of the Federal Government on research and development, on industrial research and development, and on university and non-profit research, it draws extensively on reports issued by the National Science Foundation. A section on scientific and technological man-power is likewise based on two reports, "Student Deferment and National Manpower Policy" and "A Policy for Scientific and Professional Manpower", issued by the National Manpower Council; these are to be followed by a third, "A Policy for Technical and Skilled Manpower". The second of these reports estimates that, of the five millions now engaged in scientific and professional work, more than a million are teachers, nearly a million are engaged in medical and health services and more than half a million are engineers; but of 155,000 workers in natural science, about 15,000 are engaged in fundamental research. Shortages in different branches of science are regarded as qualitative as much as quantitative, and it is recommended that no attempt should be made to urge school leavers to turn to particular branches of study in conformity with a predetermined national policy. Instead, expansion over the whole field of higher education is suggested, so as to overcome the

* British Commonwealth Scientific Office, North America. The BOBO Review of Science in the U.S.A. for the Year ending June 1953. (United Kingdom Scientific Mission, Canadian Scientific Liaison Office, Australian Scientific Liaison Office, New Zealand Scientific Liaison Office, South African Scientific Liaison Office.) Pp. iv+44. (London: H.M.S.O., 1954.) 2s. net.

shortages without destroying the overall balance between different disciplines, and employment practices which cause inefficient utilization of professional man-power, especially in engineering, are deplored.

During the year, new restrictions were placed on the flow of unclassified reports from the Department of Defense, which is itself financing more than a third of all scientific research in the United States, and these are likely to impede the free exchange of technical information between the United States and other countries. On March 16, 1953, the two original documentation centres of the Department of Defense were amalgamated to form the Armed Services Technical Information Agency. This Agency is expressly forbidden to make even unclassified material available except for military purposes, and those engaged in defence research are entitled to receive material only in those subject categories for which they have proved a need. Furthermore, the Agency is not to undertake the direct collection of information from foreign sources or to disseminate information to foreign governments, their nationals or representatives. Much of the unclassified material is afterwards published; but now that the services provided by the Technical Information Division of the Library of Congress are no longer available to foreign countries, delays of twelve months or more may be experienced before such information becomes available. The report points out that direct exchange between institutions may now be the best avenue still open through the International Exchange Service at the Smithsonian Institution; this, however, is limited by the small funds available and the consequent necessity of using the cheapest form of freight transport, with delays normally of several months.

It is not too difficult, however, to obtain unclassified reports from some Federal departments. The Atomic Energy Commission has always fully implemented the charge laid upon it by the United States Atomic Energy Act "that the dissemination of [unclassified] scientific and technical information relating to atomic energy should be permitted and encouraged so as to provide that free interchange of ideas and criticism which is essential to scientific progress", and the report directs attention to the wide range of the physical and biological sciences covered by the publications of the Commission and listed in *Nuclear Science Abstracts*. Expenditure on the Commission's programme during the year ended June 30, 1953, is estimated at 4,000 million dollars, of which about 300 million was spent on research and development. Most of the section dealing with atomic energy in this report is concerned with the development of nuclear power for industrial or domestic purposes. In a statement issued on May 26, 1953, the Commission proposed interim legislation to permit non-government ownership and operation of nuclear power facilities, the use and transfer of fissionable and by-product materials under suitable safeguards, and the granting of more liberal patent rights than is possible at present. It also proposed to allow research and development on specific power projects to be undertaken in the laboratories of the Commission, and that a progressively liberalized information policy should be applied in the power reactor field. The objective of this policy is to further the development of nuclear plants which are economically independent of government commitments to purchase weapons-grade plutonium.

During the past year it has become evident that commercial rain-makers are losing business, but interest and activity in the physics of rain and cloud formation has greatly increased, with the growing realization of the importance of tackling fundamental physical problems first. Work continued on the theoretical and practical aspects of the use of radar in cloud detection and of radar echo-intensity measurements in the estimation of rainfall. The importance of coalescence as a mechanism in rain formation was increasingly appreciated, and the report notes a more positive attitude on the part of the United States Weather Bureau toward cloud seeding: experimental work was to start this spring in the State of Washington.

In radio astronomy, Ewen and Purcell's discovery of hydrogen-line radiation from outer space has not been followed up, although the Carnegie Institution of Washington will shortly bring into operation an extended Wurtzberg antenna, with Ewen-type receiving equipment. Practically no 'radio star' work has been done, but three prominent 'radio nebulae' have been identified with astronomical objects that can be 'seen'.

On April 14, 1952, a complete table of assignments covering the very-high-frequency and ultra-high-frequency bands was released, and there is considerable activity in the development of ultra-high-frequency receivers. The design of the high-power output stage presents the most difficult transmitter problem; and in colour television, while the Columbia Broadcasting System frame sequential method is at present the officially authorized system, the door has been left open for any other system that can be demonstrated successfully.

Capital expenditure of the chemical industry during the year is estimated at 1,500 million dollars, and this includes plant capable of producing 30 million lb. of orlon a year; 50 million dollars for new plant in New Orleans for acetylene, ammonia and acrylonitrile, and expanded facilities for the production of aureomycin; a 1.8 million dollar plant for dextran, a blood plasma substitute; a 14 million dollar project for defluorinated phosphate, one by-product of which will be uranium; and 7 million dollars for a plant for phenol by the new cumene process. Plans were also announced to spend more than 700 million dollars on new plants in Texas, Louisiana, Oklahoma and Arkansas, and increasing attention is being focused on the study of water pollution and atmospheric pollution accompanying the establishment of heavy industries. Probably the most interesting development in the plastics field is the production of new semi-permeable ion-exchange membranes in two forms, which permit the passage of anions or cations, respectively; it appears most improbable, however, that the demineralization of sea-water by such processes will be economically attractive, but with brackish waters the position is more promising.

In fuel technology a final report from the National Petroleum Council maintains the view that neither the hydrogenation nor the Fischer-Tropsch process approaches a cost competitive with gasoline from crude petroleum at 12 cents per U.S. gallon; oil shale is the only alternative source that could be considered commercially. Sufficient progress is claimed with development of low-temperature fluidized carbonization for the design of a full-size industrial unit. Development work on the hydraulic transport of fine coal has been completed, and this

method is regarded as an economic proposition with a 12-in. bore pipe-line over distances of 50-200 miles. In building, the report notes the trials made with hydraulically operated back-acting diggers thought to be suitable for digging foundations and drainage trenches; with the 'vacuum-processing' of concrete and the 'vacuum-lifting' of concrete units; and with the Tournalayer system of building, in which the concrete shell of a house is cast at a central point on a building site, and then carried away and placed on its foundations.

In mechanical engineering, considerable interest has been stimulated in the hot-forming and machining and grinding of titanium alloys, and in electrical processes for shaping and finishing hard materials, and increased attention is being given to the characteristics of machined surfaces. There has been an enormous growth of research in applied mechanics, and growing interest is also noted among engineers in the science of management and in the application of operational research to management problems. In metallurgy the shell-moulding process has attracted further attention; but phenol-formaldehyde resins continue to be the only ones of industrial importance as binders when casting alloys of relatively low melting point like those of aluminium. The production of nodular cast iron continues to increase, and American foundries are now investigating the effect of adding cerium simultaneously with magnesium to neutralize the harmful effects of residual elements.

EUROPEAN PRODUCTIVITY AGENCY

FIRST ANNUAL PROGRAMME OF ACTION

THE summary of the first annual programme of action of the European Productivity Agency, published by the Organization for European Economic Co-operation, Paris, points out that a campaign to increase productivity sets both technical and psychological problems, the latter being the more difficult and important. Some of the sociological effects of technological advances may be wholly beneficial, but others, such as the need for the worker to adapt himself to new processes or new trades, may cause temporary individual problems and require careful study. Resistance to change is not confined to labour; and it is important for it to be known that, under European conditions, higher productivity in the long run means increased possibilities of employment and that any temporary risk of technological unemployment is far less grave than that facing a community which allows itself to fall behind others in the efficient use of its resources. With proper co-operation between management and labour, even technological unemployment can be avoided, if everything is done to increase the speed of adaptation to new tasks by improving vocational training and to facilitate mobility of labour by housing policy and efficient labour-exchange services.

As regards general policy, the summary indicates that the Agency aims at giving an initial impetus to groups which can show a reasonable chance of continuing and developing with fresh sources of support and at making these continuing projects self-supporting to the maximum extent. The programme

is summarized under six main headings: specific economic and legal problems; technical and administrative problems of industry and commerce; human factors of management and labour; applied research and technology; food and agriculture; and information and general services. Under the second heading, action is contemplated to bring European management to a wider understanding of the need for management education, and the creation or development of chairs of business administration in European universities and technical colleges. Further research is also proposed on the factors determining the attitudes of employers and employees to the scientific study of the selection of workers and conditions of workers, and the pooling of experience and effort in training supervisors.

In applied research and technology, the Agency's task is essentially to supplement what is being done in existing institutions, to co-ordinate such research and to strengthen the liaison between research and industry—for example, by facilitating contacts for exchanges of information and views between those in charge of the organization and administration of research. An essential task will be to improve existing channels for disseminating technological information and the study and development of new media. The establishment and development of specialized research and information centres in the main industrial sectors will be encouraged, and special attention will be given to increasing technological productivity in the building industry.

The Agency's efforts to improve productivity in the field of food production and agriculture will be directed towards the study of the economic organization of the farm as a production unit; the factors of input in agriculture, horticulture and fisheries; the marketing and distribution of output; techniques in production processes in these fields; and the exchange of information and techniques of communication.

TRIBUTE TO PROF. ALEXANDER LIPSCHUTZ

THE combined second and third numbers of Vol. 3 of *Acta Physiologica Latinoamericana* contain a series of thirty-one essays by distinguished contributors, offered as a tribute to Prof. Alexander Lipschütz on his seventieth birthday*. The articles are variously written in English, Spanish, French, Portuguese and German. The first, by B. A. Houssay, is a laudatory biographical sketch of Prof. Lipschütz; the remainder cover a wide range of subjects—reproductive and general physiology, cancer, steroid chemistry, and numerous miscellaneous biological matters—in most of which Prof. Lipschütz has himself been an active investigator. To summarize all these interesting essays is not possible in this short review; to single out a few for special mention must place the reviewer in an invidious position. His own interests, not the excellence of the articles chosen, can be the only criteria of choice.

Prof. Lipschütz enunciated the law of follicular constancy in 1930, and two papers are directly concerned with this. M. and C. Aron discuss the nature

* *Acta Physiologica Latinoamericana*. Vol. 3, Nos. 2 y 3: Número de Homenaje al Profesor Alejandro Lipschütz. Pp. vi+49-802. (Buenos Aires: Asociación Científica e Investigación, 1953.) n.p.

of the reactionary hyperactivity in the remaining ovary after unilateral ovariectomy and the factors involved in its genesis. S. Zuckerman summarizes the recent researches in his department on the question of oogenesis in adult animals and concludes that this does not occur in the rat, rabbit or monkey, though it may in the lemur, armadillo and guinea pig. Another paper with some bearing on this subject, though with far wider significance also, is that by A. S. Parkes on the conservation of gonadal tissue by deep freezing after glycerol treatment. Such tissues, after apparently indefinite storage, may behave much like fresh material on grafting.

There are a number of papers dealing with cancer research. F. Bielschowsky, discussing the influence of the ovaries on the production of chemically induced cancers, states that mammary cancers were obtained in nearly as high an incidence in rats bearing ovarian grafts as in intact animals, and that such tumours developed whether the graft formed corpora lutea or not. B. A. and A. B. Housay, A. F. Cardesa, V. G. Foglia and R. M. Pinto describe the adrenocortical tumours which develop slowly in white rats after gonadectomy. Many of these tumours eventually elaborate oestrogens, under the influence of the pituitary gonadotrophins. A. Lacassagne, L. Hurst, F. Zajdela and R. Royer, writing on the experimental production of cancer of the liver, conclude that there is no sex difference in susceptibility, and that oestrogens decrease the susceptibility, while castration of the male, the administration of testosterone to oestratees of both sexes, or of progesterone to oestrate males, increases it. A brief paper by Peyton Rous reviews cancer research over the years.

Problems relating to the action of reproductive hormones are considered in another group of papers. John Hammond writes on the effect of the plane of nutrition on hormone action, and on the curious way in which uterine infections in cattle occur much more readily under the influence of progesterone than of oestrogens. F. J. A. Paes, E. M. van Soest and S. E. de Jongh conclude that androgens take no significant share in the development of the secondary sexual characters of the female rat. C. D. de Pasqualini describes the effects of adrenal grafts in adrenalectomized rats; in such animals there is luteinization of the ovaries or hyperplasia of the Leydig cells of the testes. Some abnormality of function of the adrenal graft appears to lead to the secretion of excessive amounts of pituitary luteinizing (or interstitial-cell-stimulating) hormone. The relations between the gonads and the adrenal cortex are also discussed by A. D. da Costa. Gregory Pincus and M. C. Chang confirm the effectiveness of progesterone as an inhibitor of ovulation in the rabbit, and they also discuss the effectiveness of other related steroids.

Among the papers on steroid chemistry, R. Courrier writes on the allenolic series of artificial oestrogens, E. C. Dodds on the relation of stilboestrol to naturally occurring oestrogens, and Christian Hamburger on the ultra-violet absorption spectra of oestrogens. K. Miescher, A. Wettstein and F. W. Kahnt demonstrate the conversion by adrenal homogenate of 9:11-dehydro compound-S acetate into its 11- β -hydroxylated derivatives (17-hydroxy-corticosterone and its acetate), and this finding, they conclude, strengthens the supposition that 9:11-dehydro-steroids may represent important intermediates in the metabolism of the adrenal cortical hormones.

Other essays in this interesting collection deal with aspects of diabetes (V. G. Foglia; O. Koref, L. Vargas and A. Vukusic); cardiac activity (B. Gunther; F. Hoffmann, S. Middleton, A. Molina and J. Taleanik; O. Orías); hormonal factors in the development of inflammation (H. Selye); the discovery of uterine smooth muscle (G. W. Corner); histochemical reactions of mast cells (W. Buño); and a variety of other topics including renin, the cytology of urinary sediment as an indicator of oestrogenic stimulation, respiratory control, motor nerve section, the neurovegetative system, and certain factors influencing the voluntary intake of alcohol by rats. G. I. M. SWYER

FORESTRY IN THE SUDAN

THE annual report for July 1951-June 1952 of the Forest Department of the Sudan* is a very full and discursive document of sixty-nine pages and deals with many sides of what should be wholly the work of the forest officer alone. As an introduction, the report states "the brief description of the distribution and main uses of the forests which has been included in previous reports is repeated here". The statement of the forest policy in force, laid down in 1932, which is given in full in chapter 2 of the report, defines the division of responsibility between the Chief Conservator and governors of Provinces. The latter are responsible "for ensuring that the permanent supply of forest produce is sufficient to meet the internal requirements of their Provinces". Governors are, moreover, "empowered to declare as Provincial Reserves such areas as they consider necessary"; they are "to prepare programmes in accordance with their estimated future provincial requirements and engage staff to carry them into effect". It might be logically asked—What is the Forest Department for? The statement adds that "expenditure in this connexion will be borne by province budgets and that Governors may refer to the Chief Conservator for advice".

The Chief Conservator writes in this annual report that "twenty years have now elapsed since this policy was laid down and it is timely to review results. They are not wholly satisfactory." The provincial forests made by Governors during the period only amount to one thirty-seventh of the area of the reserved forests owing to the very natural preoccupation of provincial administration staffs with other duties and a lack of appreciation of the fact that forestry is essentially a long-term business. A revealing comment from the report is that "forestry is so dwarfed by State Agriculture in the Sudan that it is not often realized that the scale of all-round forestry here is now greater than in other African territories of comparable resources", and, it might have been added, though the forestry staff is much smaller.

The wonderful success of the Gezira undertaking placed the Agricultural Department in its present position in the administration of the Sudan. Had the gum arabic, a purely forest product, been placed under the management of the Forest Department as it logically should have been, the annual revenue received, a considerable portion of the Sudan's

* Sudan Government Forest Department of the Ministry of Agriculture. Report for the Period July 1951 to June 1952. Pp. iv + 70. (Khartoum: Ministry of Agriculture, Forest Department, 1953)

annual budget, instead of being credited to the district revenues would have come to the Department. The latter would have had long ago sufficient strength to put in force the urgent variety of work which, the report shows, is now being attempted. If it is necessary to train the forester for his duties, it follows that they cannot be carried out, nor even fully understood, by other elements of the administration. The striking example is the collection of the valuable gum arabic by the people under the aegis of the civil administration to which, as has been said, is credited this valuable revenue. It brings to mind the old days, during two-thirds of the last century in Madras, when the revenue authorities considered that the forest officer could only exercise his duties in the heavy timber forests, chiefly situated in the western half, and that he had no jurisdiction in the scrub forests in the eastern half of the Presidency, the produce of which was credited to the district revenue with no supervision over its collection. The points of view of the Governor-General and the Secretary of State for India in this matter were at length accepted by Madras, and all forests and their products, including timber-producing or scrub valuable for firewood and grazing and some other minor products, were placed under the Forest Department and all revenues therefrom credited to that Department. It is not too much to believe that, had the gum arabic product been placed under the Forest Department in the Sudan even as late as 1932, the methods of collection and regulation of the so-called 'gardens' would have long ago been under a working plan and a larger annual revenue could be now realized (see para. 179 of the report).

With the comparatively recent expansion of the work during 1951-52, 496,469 feddans of new reserves were gazetted, bringing the total of reserved forest up to 722,553 feddans (1,178 square miles), which seems very little to show for fifty years of work. But taking areas under reservation, the area totals 3,051 square miles, representing 0.314 per cent of the total area of the Sudan. It is noted in the report that Uganda has already more than 7 per cent of reserved forest. In knowledgeable quarters it is judged that 15 per cent of well-distributed forests is none too much for safety in an arid tropical country. A very considerable amount of planting has been carried out during the year, a large planting campaign having been organized.

The staff of the Department amounts to twenty officers (two under training in the United Kingdom) and seventy-six in the subordinate ranks, other than forest guards, who are not mentioned. If this staff was doubled it would scarcely be able to carry out all the duties facing a Forestry Department entrusted by its Government to undertake all the forestry work in the country. Enumeration surveys of all forests of commercial value, in which saw-mills appear to be multiplying, and, perhaps even more important, investigations into the ownership of supplies from which the large demands for firewood and charcoal are being obtained, would appear to be urgent. For example, one reads in the report on this subject: 'For the southern division the Conservator writes of the increased prosperity in Khartoum Province, reflected in much building with an accompanying increase in the demand for firewood to burn the bricks. The demand far exceeded the supply of firewood imported by the Department into Khartoum Province on rail, with the result that the illicit cutting of desert 'scrub' forest showed an unwelcome

increase, although no widespread devastation took place.' Who is to be the ultimate sufferer through the 'illicit cutting of the desert 'scrub' forest'? Moreover, who is the authority directly responsible? Is it the Forestry Department?

In the seventies of the last century a somewhat similar situation arose in the so-called *ruths* in the Punjab plains, covered by a desert scrub, on account of its use for firewood. The newly building railways demanded wood fuel for running the engines and wished to have the exclusive use of the scrub; the calculations of the possible available amounts included digging out and utilizing the roots, thus ensuring a resultant desert. This was prevented by placing the management of the *ruths* under the management of the Forest Department, which, as the Secretary of State said, had been brought into the administration and trained for the purpose of undertaking this type of work. E. P. STUBBING

ROBERT JAMESON AND THE ROYAL SCOTTISH MUSEUM, EDINBURGH

A PAPER by Mr. V. A. Eyles on 'Robert Jameson and the Royal Scottish Museum', published in the April issue of *Discovery*, is particularly appropriate in view of the centenary this year of the Royal Scottish Museum, Edinburgh, for it was through Jameson's enthusiastic labours in the College Museum that eventually it attained such a status that it was taken over by the State. In a foreword, Mr. Eyles describes the origin of the University of Edinburgh and its relationship to the civic authorities. He then records the circumstances of the establishment of the chair of natural history and its progress under Dr. Robert Ramsay, Dr. John Walker and Robert Jameson, who succeeded in 1804.

The professor of natural history was *ex officio* keeper of the Museum, and Jameson, in addition to a long and distinguished career as a naturalist, was also zealous in his care of the collections. Eventually geology became his chief subject, and he was caught up in the great Huttonian-Wernerian controversy. He studied under Werner in the mining town of Freiberg for nearly two years; and Eyles records that he 'absorbed uncritically all that he [Werner] had to say' and eventually became the greatest protagonist for Wernerism in Britain. But his enthusiasm for geology did not mean the neglect of the other branches of natural history, for he lectured on meteorology, hydrology, mineralogy, geology, botany and zoology—truly a formidable list. The general impression among his students, including Charles Darwin, was that the lectures were rather dull but accurate, and unrelieved by any humour or figures of speech.

As a museum man, Jameson experienced all the trials of a present-day curator, including lack of accommodation and funds. In 1852 Jameson prepared a report on the Museum, and eventually the collections were accepted by the State in 1854. The foundation-stone of the Royal Scottish Museum in Chambers Street was laid by the Prince Consort in 1871. All interested in the history of geological studies and their influence on contemporary thought are indebted to Mr. Eyles for his painstaking paper.

BOOK REVIEWS

CELL PHYSIOLOGY

Pathology of the Cell

By Prof. Gordon Roy Cameron. Pp. xv+840+64 plates. (Edinburgh and London: Oliver and Boyd, Ltd., 1952.) 84s. net.

AS text-books on a major subject like pathology get increasingly larger they tend to become reference books and few students can be expected to read them from cover to cover. Many books of this kind are in essence scarcely more than carefully systematized descriptions of abnormal microscopic and macroscopic structure. The sequence of the chapters, though often varied with considerable ingenuity, does little to conceal the essential sameness of the information. It is indeed difficult to present a major subject in an entirely new way because systematization and the burden of accumulated facts allow almost no scope at all for the broader concepts and freedom of treatment characterizing many works in the literature of biology as a whole.

Prof. Gordon Cameron has written a book of monumental size and quite exceptional scholarship. It is not a conventional text-book of pathology or a standard work of reference on morbid histology, but a very fascinating story in which function and structure in disease have been linked with what is known about normal and abnormal cells. The text consists of four parts: the normal cell, the abnormal cell, a critique of the cell theory and cellular pathology in the future.

In the past decade or so cellular physiology has undergone amazing progress. It is everywhere predominant in this book, the material of which ranges from plants and protozoa to man. The author deals extensively with the historical development of the cellular theory which some may hesitate to read fully because there is so much else which commands attention in the more familiar modern era of the subject, or perhaps because not everyone can be as deeply interested as the author in the philosophies of the German nineteenth-century science. Each chapter, however, has a concise summary and so one can delve deeply or superficially as the spirit moves.

Prof. Cameron is no pundit concealing the sources of his knowledge for the sake of brevity or elegance of style. In fact, this book might almost be said to be excessively documented to the extent of being difficult or uncomfortable to read. This is a fault not of style but of the technique in correlating the references lists with the text. If each paper quoted had been given a serial number inserted quite inconspicuously at each appropriate point in the text there would have been no need to interrupt some sentences with a list of authors' names and dates, sometimes extending over half a page.

The chapters on cellular degeneration and inflammation are especially noteworthy for a functional, rather than a morphological, approach. The vital biological process is envisaged rather than the static pathological state. But clearly the author is restless for the fruits of the almost unlimited field which the investigation of the sub-microscopic normal and abnormal structure is bound to provide. The pathology of the future, which is outlined in Part 4 of this book, is both imaginative and stimulating.

There are more than six hundred pages of text, with an excellent bibliography and subject index. The numerous illustrations are well reproduced, but a few of them appear to have been inserted more as an afterthought, marrying somewhat awkwardly with the text.

Written over a period of eleven years this book cannot fail to be a source of constant inspiration to research pathologists and biologists. It is indeed a remarkable achievement.

E. S. HORNING

SOCIAL BEHAVIOUR OF BIRDS

The Herring Gull's World

A Study of the Social Behaviour of Birds. By Dr. Niko Tinbergen. (The New Naturalist Series.) Pp. xvi+255+30 plates. (London: William Collins, Sons and Co., Ltd., 1953.) 18s. net.

THIS is a fascinating book. It consists of a detailed account of the ordinary behaviour of a common bird; but it is full of scientific interest in the physio-psychological analysis of these activities. It is rigorously objective and exact in its treatment; but its clear expositions are pleasantly free from all but a minimum of technical terms. The only subjective note that is allowed to intrude is one of keen enjoyment on the part of the investigator; and that the reader will find infectious.

Here modern ideas of animal behaviour, on which Dr. Tinbergen—formerly of Leyden, now of Oxford—is a distinguished authority, are exemplified in a single species. The behaviour of the herring gull is minutely followed throughout the season when close observation is possible, from first arrival at the nesting colony, through pairing and incubation, to the phase of family life. That the author is one of those students of behaviour who prefers to make his observations in the field rather than the laboratory, even when experimental methods are used, will earn the sympathy of readers who are primarily naturalists.

The herring gull's world is seen to be governed by a few major drives or internal urges. Under the influence of whichever predominates at the time, the bird shows a delicate sensitivity to special external stimuli and a capacity for reacting to these by corresponding special types of behaviour. When the response to a particular stimulus is innate, it is rigid and almost automatic, unilluminated by insight into the ends served: the reaction to hard food is to fly up with it and drop it from a height; but experience brings no awareness that the food must be dropped on hard ground for the behaviour to be effective. Yet, in other cases, a reaction may be 'conditioned' by learning: the bird quickly learns to recognize its own mate, and learns to recognize its own chicks (although never its own eggs) within about five days.

One of the reactions most closely studied here is that of the chick seeking food by pecking at the red spot on its parent's beak. Experiments with dummies of various shapes, sizes, patterns and colours demonstrated how definite this is. The response is indeed evoked by a red spot when presented without any-

thing otherwise resembling beak or bird; and the chick may repeat it hundreds of times in spite of failure thus to obtain food. It is even possible to evoke a "supernormal" response by exaggerating the feature; and in this regard the author cites woman's use of lipstick as an analogy.

Much that is most puzzling in the behaviour of birds becomes explicable in terms of 'displacement activities', in accordance with what Edmund Selous long ago called "the law of the interchangeability of energies". When an urge is frustrated, it finds an outlet in some action belonging to quite a different context—like the cat, suddenly unsure of itself, which stops to wash its face. These irrelevant actions are often characterized by being incomplete and may become stereotyped in a ritual form. Actions of this type make up a large part of the behaviour of birds, and not least in those species which are markedly social in the reproductive phase of their lives.

The interesting explanation is offered of the pair's defence of 'territory' around the nest, in the case of a colony on open ground, that dispersion adds to the value of the cryptic coloration of eggs and young. The observed effect of predation is indeed a wider spacing of the nests when the birds lay again.

Dr. Tinbergen frankly enjoys wrestling secrets from the living things which he studies. He likens his pleasure to that of the chase: "I am not in the least ashamed," he says, "to confess that my photographs and this book are my trophies." Many will gain by examining them.

LANDSBOROUGH THOMSON

NATURAL HISTORY OF THE PINKFOOT GOOSE

A Thousand Geese

By Peter Scott and James Fisher. Pp. 240 + 17 plates. (London: William Collins, Sons and Co., Ltd., 1953.) 21s. net.

THE late Gino Watkins once quoted to us: "When a man really wants to do a thing, he will succeed". Peter Scott certainly demonstrates the fundamental truth of this seemingly sweeping statement. Urged by a deep-rooted interest in water fowl, almost bordering on an obsession, he has managed to bring together a unique collection of live Anatidae on the New Grounds near Slimbridge, has travelled widely for the purpose of collecting and observing out-of-the-way species, and has recently embarked on a very ambitious population study of the pinkfoot, a goose wintering mainly in Britain and breeding in the Arctic. This idea was conceived at a time when it was not yet known for certain where the main breeding colonies of the species were.

At first, in the late 'forties, the geese were captured (with the now famous rocket-net technique), ringed and otherwise marked on various wintering grounds in England and Scotland; but in 1950 Scott decided to go to the heart of Iceland where, he had strong reasons for believing, the largest breeding colonies must be found.

Together with Miss Philippe Talbot-Ponsonby (now Mrs. Scott), the well-known Icelandic ornithologist Finnur Gudmundsson, and James Fisher he set out in June 1951, and in the beginning of August returned, having found the large colonies which he knew must be there, having made provisional counts,

and having ringed 1,151 geese—a remarkable achievement.

"A Thousand Geese" is the narrative of this expedition, written in a simple, straightforward style, which brings out the atmosphere of such a delightfully single-purposed enterprise, during which a man, while working hard, can get a good mental rest by living close to Nature.

In a footnote at the end of the book Scott adds that he went again in 1953 and that this time, using the experience gained in 1951, he caught 9,005 geese. According to his estimates about "one in five of the world pinkfoot population now carries a ring". The repeated sampling makes calculations of the Iceland population possible, and the large-scale ringing will provide valuable data on various aspects of pinkfoot population ecology. Excellent planning, great tenacity of purpose, and exceptional skill has enabled him to make this admirable start.

Apart from the story, the book contains, in an appendix, detailed information on the status of the pinkfoot in Spitsbergen, on its status in Greenland, notes on the birds observed at the camp site, a list of plants found (compiled by Gudmundsson), estimates of the local pinkfoot population, and a bibliography of the breeding distribution of the species.

The illustrations are excellent, and special mention should be made of the very attractive book-jacket.

N. TINBERGEN

A HANDBOOK FOR BIRD- RINGERS

Bird-Ringing

The Art of Bird Study by Individual Marking. By R. M. Lockley and Rosemary Russell. Pp. viii + 119 + 8 plates. (London: Crosby Lockwood and Son, Ltd., 1953.) 9s. 6d. net.

R. M. LOCKLEY is a 'pioneer of British bird observatory work, and few ornithologists can have exceeded his total of birds personally ringed. He also has many European correspondents in this field, and his collaborator, Mrs. Russell, has had recent experience of North American 'banding' methods. Their first three chapters are written most entertainingly and describe the history, value and technique of bird-ringing succinctly but with interesting illustrations. At the same time, there is a needed emphasis on care. Bird trapping and ringing have become enormously popular in recent years and have attracted a large number of enthusiasts with little previous knowledge of ornithology. But birds are delicate organisms, and it is essential scientifically—as well as most desirable on humane grounds—that they should be caused as little discomfort as possible when they are caught and afterwards handled.

More than half the book is taken up with illustrated descriptions of traps and other catching devices. This is quite reasonable. Provided the need for care and gentleness is realized, the actual process of ringing a bird is simple and, in any event, can only be learnt in the field. The real art lies in catching the bird. Most of the designs have already appeared in the first field guide of the British Trust for Ornithology (1950) by P. A. D. Hollom, but the authors have various developments and modifications to record and add some useful American patterns excluded by the Trust's booklet.

The final chapters deal with recording and field equipment, and glance at the ancillary techniques of weighing, measuring and parasite collection. A full list of the British bird observatories makes an important appendix. The authors exclude, however, any detailed references to ringing outside the British Isles on the grounds that the literature received was "far too voluminous"; but a list of the more important schemes would have been welcomed and could have replaced the four pages devoted to a "Model Life-Study by the Ringing Method". Some of the works mentioned in the text by abbreviated titles are not recognizable in the "Select Bibliography", which includes remarkably few titles directly relevant to ringing methods and thus at least shows the need for this well-produced little handbook.

BRUCE CAMPBELL

WEST AFRICAN "BEEF"

The Overloaded Ark

By Gerald M. Durrell. Pp. 238. (London: Faber and Faber, Ltd., 1953.) 15s. net.

THIS is an account of a collecting trip to West Africa by two naturalists who were determined to go to the tropics and enjoy the wild life of them, but who could raise the necessary money only by undertaking to collect wild animals for European zoos. They came back poorer financially than they left; but they did manage to cover the greater part of their expenses, and they were enormously enriched by their experiences. Gerald Durrell and his companion, John Yealand, are excellent naturalists, and the first, who, against the advice of the second, has written this book, has the flair for writing that runs in the family and has produced a most entertaining volume.

The steaming forests of the Cameroons teem with animal life if only you can find it; but the human collector toiling painfully on foot through the tangled undergrowth is at a great disadvantage compared with the animals that can creep under the obstructions, swing from tree to tree over him, or soar into the air above everything. By enlisting the help of the natives who have been born and bred in the forest it is, however, possible to come up with the wild creatures and to capture specimens of "beef", as the wild animals of the region are called in the local pidgin.

The author and his companion were able to get together a good collection of birds and animals—perhaps the most interesting of them all were the angwantibo and the otter shrew. The angwantibo, *Arctocebus calabarensis*, is a very rare lemuroid found only in the forests of the British and French Cameroons; there are very few specimens in museums, and it had never been brought alive to Europe. Scarcely a single zoologist had ever seen it alive, and practically nothing was known of its way of life. After much fruitless searching a native casually brought one in, caged in a basket of palm leaf; it placidly accepted captivity and was successfully brought to the London Zoo. *Arctocebus* much resembles the potto; it is nocturnal, spending the day asleep clinging to a branch with its head tucked down between its arms, becoming active at night and feeding upon fruit, insects and meat. Durrell was also fortunate enough to obtain two otter shrews, or giant water shrews (*Potamogale*); but after they

had apparently settled down comfortably in captivity they both inexplicably died. The account of the finding and capture of the first in the middle of the night under a rock in a mountain torrent is a splendid bit of descriptive writing, as indeed are many other passages in the book. The natural diet of the otter shrew appears to be freshwater crabs, for of all the food-stuffs offered they were the only things eaten. The author was able to wean them on to an artificial diet which seemed to suit them well until their sudden deaths showed that something was lacking. Such are the delights and disappointments of the animal collector.

This is an excellent travel book that really gives the reader the feel of the tropical forests of West Africa; it is vivid but objective, and avoids purple passages—it will fill naturalists with envy of those whose enterprise took them on such a fascinating zoological journey. The skilful line drawings by Sabine Baur are an ornament to the work.

L. HARRISON MATTHEWS

CULTURE OF ALGAE

Algal Culture

From Laboratory to Pilot Plant. Edited by John S. Burlew. Pp. ix+357. (Publication 600.) (Washington, D.C.: Carnegie Institution of Washington, 1953.) 1.25 dollars.

IT has not often happened that a scientific programme of uncertain outcome, which is only worthwhile if it has practical results, has attracted so much attention, so many fertile brains and even very considerable funds. In biology it has happened for the first time.

The reason is the obvious necessity to supplement our normal field-crops, which cannot be increased much above the present level, with some kind of food of a different origin. The rising number of inhabitants of the earth, due to reduced mortality, puts pressure on our inventive capacities, and one hopes to find a way out with the help of algal cultures.

Conforming with the general tendency of our time to plan ahead, means and energy are being directed towards growing algae on a gigantic scale which, twenty years ago, would have appeared ridiculous to propose. Compared with the food value of the algae hoped for, the transformation of radiant energy plays a minor part in the discussions.

At present the solar energy reaching the earth is, to a large extent, wasted. No better means for utilizing it is known than the pigment system of green plants, and it seems more reasonable to use the algae produced, if sufficient quantities are forthcoming, as a food for man and animals than to burn them in boilers. The notion of growing algae as food was conceived in Germany by O. Warburg during the First World War, but did not begin to stimulate action until the Second World War, and then mainly in the United States, while minor efforts are reported from Great Britain, the Netherlands, Israel, Germany and Japan.

The main aim is to attain optimum utilization of radiant energy from the sun; the main difficulty being the protection against infection with other, for example predatory, organisms. A closed, though not necessarily sterile, apparatus of enormous dimensions is required. One hopes to produce a larger amount of

dry organic matter with algae than with customary field-crops which cover the ground and form an almost uninterrupted photosynthetic layer only during a short part of the year.

A great effort is directed towards the elucidation of the main factors in algal growth and reproduction, for example, the effect of light-intensity, temperature, different nutrient solutions, density of cell-suspension, intermittent light, etc. At the same time, the dimensions of the experiments are steadily increased, from test-tubes and flasks to large bottles and so on, eventually to pilot plants.

So far no alga has proved superior to *Chlorella pyrenoidosa* in productivity; but it seems possible that other properties may in future play a part: among others, easier harvesting, hardness against high temperatures as caused by insolation, or against chemical admixtures to the ordinary agricultural fertilizers which will have to replace the pure chemicals now in use.

The contributions by various authors are of unequal value. Those who believe that pure cultures are not indispensable for achieving heavy yields continuously are in the minority but not yet defeated, although their achievements are not impressive. Some new discovery may alter that. There is a great deal of information in this volume which will stimulate research in many ways. E. G. PRINGSHEIM

PLANT GENERA

Plant Genera

Their Nature and Definition. A Symposium by G. H. M. Lawrence, I. W. Bailey, Arthur J. Eames, Reed C. Rollins, Marion S. Cave and Herbert L. Mason. With an introductory essay on Generic Synopses and Modern Taxonomy by Theodor Just. (*Chronica Botanica*, Vol. 14, No. 3.) Pp. 91-180. (Waltham, Mass.: The Chronica Botanica Co.; London: William Dawson and Sons, Ltd., 1953.) 2 dollars.

THE genus occupies an important place in the hierarchy of taxa. Historically, it was recognized as a reasonably clear concept before the species or the family. Nomenclaturally, it is the basis for the manufacture of most family names and forms the specific name in combination with the specific epithet. Phytogeographically, the ranges of genera provide data (and problems) that are often of greater significance than those yielded by the ranges of species or families. There are thus valid reasons for periodically reviewing the generic concept.

The symposium on plant genera to which notice is given here was apparently largely initiated by Dr. F. Verdoorn, the editor of "*Chronica Botanica*", who contributes a foreword in which he pleads for "a national or international scheme which will result in the preparation of a complete, somewhat uniform, series of generic floras".

In an introductory essay Theodor Just notes that we now recognize the need for different kinds of genera and, while supporting the scheme for generic floras, shows that these must be prepared by long-term team work. G. H. M. Lawrence refers to various taxonomic "trouble-spots" and declares his belief "that the answers will not be found, until we taxonomists function as synthesizers, until we focus on each problem all the pertinent data to be had from related fields of botanical effort". This emphasis

on what has been called synthetic taxonomy is increased by other contributors, as by I. W. Bailey in an anatomical approach, A. J. Eames for floral anatomy, R. C. Rollins with regard to cytogenetics, M. S. Cave for cytology and embryology, and H. L. Mason in dealing with the role of plant geography in taxonomy.

As many of the writers clearly point out, no one set of criteria, no group of characters from a restricted field can alone result in a widely satisfactory delimitation of genera (or other taxa). The difficulties, practical and theoretical, of utilizing diverse 'characters' in taxonomy are not to be gainsaid. Much modern work has shown that they can be overcome and that the results can be expressed, at least to a very large extent, within the existing framework of taxonomy. Subsidiary schemes are often useful if only temporarily and within narrow limits, but no general replacement of the species-genus-family hierarchy has yet been proposed and tested to meet with wide acceptance.

The idea of preparing "generic floras" or "genera plantarum" to include all cryptogams and phanerogams needs careful consideration. Genera are composed of species and, concretely, species are composed of individuals. It may be argued that delimitation of genera should succeed, not precede, the study of the species involved. In other words, if the modern methods of synthetic taxonomy be accepted, monographic work is essential before the genera can be satisfactorily determined. There is a danger in deciding on generic criteria and generic limits without fully examining every species and ultimately every available specimen and all data. It is true that a genus can often be adequately determined without settling every specific and intra-specific nomenclatorial problem but not without fully studying the 'characters' of, and within, all the species and specimens available. The question then arises: "Is it not worth while spending the extra time and properly monographing the group?" W. B. TURRILL

CHEMISTRY OF TISSUE SECTIONS

Histochemistry

Theoretical and Applied. By Dr. A. G. Everson Pearce. Pp. viii+530+35 plates. (London: J. and A. Churchill, Ltd., 1953.) 60s. net.

AS Dr. Pearce says in his preface: "Histochemistry can transform the descriptive sciences of biology into dynamic and functional sciences". His book "is an endeavour to compass the whole of histochemistry as applied to tissue sections".

The book opens with a short chapter on the history of histochemistry, followed by a discussion of fixation and freeze drying. Then proteins, nucleic acids, carbohydrates, lipids, carbonyl compounds, various enzymes, pigments and inorganic constituents are treated in succession, and to conclude there are brief chapters on physical methods and appendices, compiled in 'cookery-book' style, on histochemical procedures.

To write a text-book on a subject which is still in its early stages of development is to offer many hostages to fortune. What fortune will do with them remains to be seen. In the meantime this book constitutes intelligent comment on the present position in histochemistry, which will be of interest

to all who are concerned in the scientific development of the field. The appendices will be appreciated by the many workers who are beginning to make empirical use of histochemical methods.

The discussion in this book is most valuable when it is concerned with problems in organic chemistry and biochemistry, and is notably weak on the physical side. Since the main intention of the author is to facilitate qualitative and diagnostic studies, which depend on chemistry rather than physics, the weakness on the physical side is not of major importance.

The chapter on freeze drying is the best of the physical sections. For the most part it wisely follows the recent publications of L. G. E. Bell, and where it deviates is liable to error: for example, on p. 36 the dryer manufactured by Edwards and Co. is classified among the outmoded vapour-trap dryers, whereas it is an approximation to a mean free path dryer. The discussion of diffusion errors is very limited in its scope. The chapter on physical methods devotes less than two pages to the techniques of visible and X-ray spectrophotometry, doing quite inadequate justice to the work of Caspersen, and not mentioning the valuable contributions of Wilkins and other members of the King's College biophysics group. There is also a tendency to underestimate the importance of the work of a number of authors, for example, Brachet, Bourne, Caspersen, Chèvremont and Verne, and perhaps to be overkind to the present reviewer. These faults, however, are minor in relation to the author's purpose.

This work has a double interest, being of value both to those who wish to develop histochemistry as a precise scientific tool and also to those who wish to use histochemical methods in a manner analogous to histological procedures. The usefulness of the latter point of view is sometimes under-estimated. It does not matter, for example, that a histologist does not know exactly why a section stains with haematoxylin and eosin, provided the results he obtains are repeatable and assist diagnosis in a reliable way. Similarly, a histologist may use histochemical techniques for staining sections and will be justified if he is thereby assisted in diagnosis. Whether the method is a precise one on the chemical and cytological level may be irrelevant.

J. F. DANIELLI

MALE STERILITY

La Sterilità nel Maschio

Fisiopatologia degli Organi della Riproduzione. Diagnostica e Terapia dell'Infertilità Maschile. Da Guglielmo Longo. Pp. xix+520. (Salerno: Diffusione Scientifique Internationale, 1953.) 4000 Lire.

GYNAECOLOGY is a branch of some antiquity in medical science: its counterpart, andrology, has been practically non-existent as such until relatively recently; in fact, it is only beginning to emerge in emancipation from general medicine, endocrinology and urology. The reason for this may be sought, partly at least, in the circumstance that in the not so distant past the blame for involuntary conjugal sterility has been conventionally apportioned to women, nearly all earlier attempts at clinical investigation having been resisted and scornfully rejected by the 'stronger' sex. However, for some time now, it has been dawning upon clinicians and

scientific observers alike that, in a hitherto unsuspected proportion of cases—at least 25 per cent of the total number of sterile marriages—it is the male partner whose sterility or subfertility lies at the root of the trouble.

Quite apart from these considerations, recent years have witnessed an upsurge in scientific, socio-economic and medical interest throughout the entire field of human reproduction; this being amply reflected in the formation in most countries of the world of learned societies concerned with the study of fertility and sterility in the human race. Thus, in Great Britain there exists the Society for the Study of Fertility, which publishes annually its Proceedings; and in the United States, the American Society for the Study of Sterility, which publishes the periodical *Fertility and Sterility*, occupies a similar position.

The aim of Dr. Longo's treatise on sterility in the male is twofold: (1) to co-ordinate and disseminate modern knowledge in the field of human reproduction; (2) to focus the attention of his medical colleagues upon the responsibility of the male partner in marital sterility. The book is composed of four parts, of which the first deals at length with the anatomy of the male reproductive tract, physiology of reproduction, including its sex-psychological aspects, semen morphology, and endogenous and exogenous factors which influence semen characteristics; the next part is concerned with more specifically clinical aspects of male infertility due to anatomical or endocrinological causes; Part 3 is a survey of clinical and laboratory methods of semen evaluation, pp. 397-441 offering a detailed account of current methods of semen analysis; the last part of the book is devoted to preventive and therapeutic measures to be adopted in cases of male subfertility; a brief outline of the technique of testicular biopsy and vasopuncture is included.

The literature is conscientiously quoted and the author is equally appreciative of European and American scientific work. The text is lucidly written so that it is possible to follow without difficulty the gist of each section even if, like the reviewer herself, one can claim but limited knowledge of Italian. Some of the illustrations would doubtless benefit from the use (in a future edition) of higher quality paper. Coming from the home of some of the most illustrious pioneers in the field of reproduction, to name only Malpighi, Spallanzani, Mantegazza, Sertoli, Dr. Longo's is an effort thoroughly worthy of the tradition established in Italy by those early investigators and actively maintained by the present generation of scientific and medical research workers.

C. LUTWAK-MANN

COMPARATIVE PHYSIOLOGY OF ANIMAL PIGMENTS

Animal Blochromes and Structural Colours

Physical, Chemical, Distributional and Physiological Features of Coloured Bodies in the Animal World. By Dr. Denis L. Fox. Pp. xiv+379+3 plates. (Cambridge: At the University Press, 1953.) 60s. net.

IT is unusual indeed for a work on animal colours to be as comprehensive as this latest review by Prof. D. L. Fox. The compression of a vast amount of material into a limited space can so often result

in a treatise of interest only to the specialist. But in this case the author's consciousness, his first-hand knowledge of so wide a field in this domain and, above all, an enthusiasm born of æsthetic appreciation of the wonderful diversity of natural coloration have yielded a work which will command interest throughout, and even beyond, the realm of biology.

The author has himself made notable contributions to our knowledge of structural colours in animals, and his authoritative discussion is a welcome addition to the rather infrequent reviews of this fascinating subject. Many readers will no doubt be surprised to learn of the extent to which structural colours occur as a result either of scattering (Tyndall blues) or of interference at a laminated surface (iridescence of birds and insects). Further examples are found in the 'structural whites' of butterflies, while the elytra of the genus *Serica* carry an accurately ruled diffraction grating with 0.8- μ spacing. A preliminary account of the physical basis of colour is given in terms which, though elementary, are adequate for an appreciation of the colour-producing tegumentary structures of which numerous examples are described.

That the chapter on carotenoids is the largest is scarcely surprising in view of the author's eminent position in this field. While the chief emphasis is on comparative physiology, useful but necessarily brief discussions of carotenoid chemistry and of isolation methods are included. A great difficulty in surveying these pigments lies in the multiplicity of reports on their isolation and their prompt naming after the animal origin. To classify the numerous synonyms and to produce a balanced review requires a deep inside knowledge of the development of carotenoid studies. There is no doubt that the chapter will be regarded as an outstanding contribution to our knowledge of these pigments.

A survey of tegumentary colouring is essentially completed by an account of the indole pigments. Apart from the striking Tyrian purple these pigments come mainly under the heading of melanins, a series of ill-defined grey to brown pigments which offer little attraction either as biochromes or as problems for the chemist. However, they play interesting parts in cephalopod inks and as the dark backgrounds essential for the full brilliance of Tyndall blues.

While the preceding pigments are biochromes in the true sense inasmuch as they so often appear to be produced for adornment, others have a more utilitarian role and add little or nothing to external coloration. Of the latter type the most widespread are the tetrapyrroles and in particular the derivatives of hæmatin. It is unfortunate that the introductory chemical survey of these pigments lacks the conciseness of the rest of the book. No elementary account of hæmatin compounds is possible unless the underlying significance of the ferrous-ferri relationships and the distinctive properties of derivatives at the two levels of oxidation are made clear. Such a statement as "the older, rather indefinite term hæmatin is approximately equivalent to hæm" obscures the whole basis of these relationships. Furthermore, the statement that the "exact function [of the cytochromes] in the organism remains yet to be described" completely contradicts the extensive and precise information now available on their respiratory function.

Shorter chapters provide useful summaries on chromolipoids, quinones, anthocyanins, flavones, purines, pterins and flavins. The latter group scarcely qualify as biochromes, their interest being

purely metabolic. However, it would be desirable even in so short a chapter to refer also to flavins other than riboflavin and to flavoproteins additional to the 'old' yellow enzyme of Warburg which is now of little more than historic interest.

The value of the extensive bibliography is greatly enhanced by the inclusion of titles of the papers, a convention which could with advantage be made more general.

E. F. HARTREE

ISOTOPIC METHODS IN BIOCHEMISTRY

Isotopic Tracers In Biochemistry and Physiology

By Prof. Jacob Sacks. Pp. vii+883. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 68s.

AS isotopic methods have become increasingly used in biochemical research, so the number of text-books concerned with the applications of isotopes has also increased. This recent addition to the collection discusses the principles underlying the design of tracer experiments and describes many of the results that have been obtained by the application of isotopic methods.

The first six chapters will appeal to many students of this subject as giving a lucid account, with the minimum of mathematical treatment, of the fundamental principles of nuclear physics and the general methods involved in the use and measurement of both radioactive and stable isotopes. The author is throughout concerned to stress that the use of this new technique introduces its own peculiar errors, and that tracer experiments have to be carefully designed, and, possibly more important, that the results have to be very carefully interpreted. *O sic omnes!* Some topics may seem to have been dealt with all too briefly, and there are a few statements which could lead the poorly informed reader to erroneous conclusions, for example, the statement that "the efficiency of Geiger-Müller counters for beta particles is practically 100 per cent". These criticisms are in part met by the references to other books which are given at the end of each chapter, though the reviewer has been struck by the trans-Atlantic nature of these general references. Without exception they are references to American-published books, and almost without exception the authors are themselves American investigators.

The second and major part of the book, consisting of ten chapters, leaves one much more doubtful as to its general usefulness. These chapters, which are almost entirely biochemical, describe the experimental results which have been obtained in the main fields of biological research using isotopic tracer methods. There is a great deal of information here and it must have cost the author much energy to collect it; but if the purpose of this section is to show by selected examples how tracers have been applied in particular cases and how the results have been interpreted, then all the material presented here is not necessary. Furthermore, since the material is divided into chapters dealing with carbohydrate metabolism, protein metabolism, lipid metabolism, etc., there is a tendency to assume that one is being given a complete account of the development of the field, though of course no mention is made of the not inconsiderable advances which have been made in biochemical knowledge without the use of

isotopes. In addition, the work described here is again drawn almost entirely from American sources, and one is in fact being given an account of the main contributions by American biochemists and physiologists which have involved isotopic methods. This may be justified in a history of American biology; but one doubts its necessity in this particular book. Nevertheless, the material presented is described with masterly clarity, and if its limitations are realized, is well worth reading for its own sake. It should also be said, in all fairness, that two of the chapters in this second section of the book, namely, Chapter 7 on the movement of ions across boundaries and Chapter 16 on photosynthesis, are exempted from some of the criticisms given above, since in these subjects the major advances have been made only since the availability of tracer methods.

Prof. Sacks has written a book which is in many ways a useful addition to the literature of what his countrymen like to call 'tracerology'; but one cannot help feeling that his contribution would have been more generally useful and welcome if the first six chapters had been extended to, say, twelve chapters at the expense of the remaining ten.

The book as a whole seems to be remarkably free from errors and misprints, and the publishers are to be congratulated on the quality of the printing, paper and binding.

WILLIAM C. HUTCHISON

THE PSYCHOLOGY OF PERSONALITY

The Structure of Human Personality

By H. J. Eysenck. (Methuen's Manuals of Modern Psychology.) Pp. xix+348. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1953.) 37s. 6d. net.

DR. EYSENCK of the Maudsley Hospital, London, is already well known for two major contributions to the literature of personality, "Dimensions of Personality" (1947) and "The Scientific Study of Personality" (1952). Although these books owed much, and contained numerous references, to the work of others, they were primarily concerned with giving an account of the investigations carried out by Eysenck and his associates. The present book, on the other hand, is a systematic and critical account of the field as a whole in which Eysenck's own work and its conclusions, though of course they colour his general treatment, are explicitly mentioned only in their appropriate contexts. It is, therefore, the complement of its two predecessors. Taken together the three books are a vigorous and important, if controversial, contribution to contemporary psychology.

Since the publication of Allport's "Personality" (1937) there has been a growing recognition that personality is perhaps the most appropriate integrating concept in psychology. It is defined by Eysenck in the present book as "the more or less stable and enduring organization of a person's character, temperament, intellect and physique, which determines his unique adjustment to the environment" (p. 2). The concept of personality is not only of importance in psychiatry and in most of the applied fields of psychology, but also, as recent work has shown, in many laboratory investigations into apparently quite narrowly specific topics. There is much less agree-

ment, however, as to how this highly complex organization is to be studied. In the controversies which centre around this issue Eysenck is a protagonist. There are no half-measures about his point of view; he is wholly with those who believe in an analytical, mathematical and formally correct scientific approach; he is wholly against all that is untestable, qualitative, verbal, and 'holistic'. He believes not only that personality ought to be studied by the same objective methods as are used in the physical sciences, but also that it can now effectively be so studied. He looks ultimately for "the construction of a mathematical model of personality organization, and the derivation of testable hypotheses from this model by means of the hypothetico-deductive method" (p. 322).

In its approach to this ideal Eysenck's work stems chiefly from the 'London school', of which the main theoretical framework, deriving from Sully, McDougall and Burt, is that of hierarchical structure, and the principal technique, deriving from the psychometric investigations of Galton, Pearson, Spearman and others, that of factor analysis. The present work is indeed entirely devoted to a survey of the numerous factor analytic studies of personality which have been carried out mainly in Great Britain and America. No other line of work receives any serious mention, not because Eysenck is unaware of the existence of this work, but because he believes it to be of small value until factor analysis has established the basic dimensions, or taxonomy, of personality. Within the strict limits imposed by its author's point of view there can be no doubt that "The Structure of Personality" is an important book. It is not only valuable as a work of reference to many tedious investigations, it also contains a good deal of critical comment, to which all those who propose to employ factor analysis must seriously attend. For one thing at least is certain: if factorial methods are to be used at all, they must be used proficiently. Eysenck's insistence on high standards of technical competence is wholly praiseworthy.

The main doubts concern the foundations of the enterprise, and these unfortunately Eysenck does little to remove. The results which factor analysis has so far yielded in the field of personality are not sufficiently compelling to remove these doubts and to command general acceptance. These doubts not only concern the adequacy of the tests and assessments upon which the elaborate statistical structure of factor analysis is erected, but more fundamentally the adequacy of the theory of traits to serve as the firm basis of an exact science. This theory bears a suspicious resemblance to the ancient doctrine of primary qualities which so long impeded the development of the physical sciences, and it may be more than a coincidence that modern typologies, including that favoured by Eysenck, so closely resemble the classical theory of temperaments which was directly derived from that ancient doctrine. If, as is not improbable, the theory of traits is a completely false road in the study of personality, the whole factorial edifice which Eysenck and others have erected collapses. Eysenck in his enthusiasm for scientific methodology appears to forget that no methodological finesse can avail unless the right questions are being asked; and to ask the right questions often requires, as Butterfield put it in his "Origins of Modern Science" (1949), "a different kind of thinking-*cap*". Gardner Murphy in his "Personality" (1947) was perhaps aware of this when he wrote, "Neither in content, nor in method can we be said to have solved the essential problem

of the starting point from which a psychology—any kind of psychology, including a psychology of personality—could be written. . . . We shall rectify mistakes not primarily by the minor readjustments of the lines of the argument, but by recognition of the fundamental limitations of the whole present system of conceptions". Perhaps Eysenck would not wholly disagree with a statement such as this, for he more than once implies that factorial studies are provisional only, until more solid methods are available to take their place. Whether even as a provisional method their value is as great as Eysenck believes, or whether other less precise methods deserve the total rejection which Eysenck accords them, time will no doubt show.

L. S. HARNSHAW

THE PSYCHOLOGY OF SPECTRES

Apparitions

By G. N. M. Tyrrell. Revised edition. Pp. 172. (London: Gerald Duckworth and Co., Ltd., 1953.) 12s. 6d.

THIS book, the first edition of which was reviewed in *Nature* in July 1943, is a revised version of the seventh Frederic W. H. Myers Memorial Lecture which was delivered by Mr. Tyrrell in October 1942. Since that date the theory that Mr. Tyrrell then put forward has met with a growing interest, and in the present volume Prof. H. H. Price, in an admirable introduction, gives it as his opinion that the book is probably the best of all the late Mr. Tyrrell's contributions to psychical research.

Dismissing the physical theories of apparitions as almost wholly unpromising, Mr. Tyrrell turns to those of a psychological nature. To him, apparitions are hallucinations of a particular and very interesting kind, and he divides them into four main classes which, however, cannot be very sharply differentiated. These four classes are: (1) Experimental cases, in which the agent tries to make an apparition visible to a particular percipient. (2) Cases in which a recognized apparition is seen, heard or felt at a time when the person represented by the apparition is undergoing some crisis such as a moment of danger or even death. (3) Cases in which a recognized apparition is seen or heard so long after death or after some crisis that no coincidence can be supposed. (4) Cases of alleged haunted localities in which apparitions are said occasionally to be observed. Cutting across these cases there are a number of characteristics which are common in a greater or lesser degree to all four classes. Moreover, these characteristics, which are of constant occurrence in the statements of the various witnesses, suggest that, in the majority of cases, the accounts are not merely the inventions of imaginative persons, but that they describe actual incidents which have occurred within the experience of the percipients.

One of the main features of Mr. Tyrrell's theory is what he terms the 'idea-pattern', which is the dramatic production of the agent's idea, the apparition itself being the sensory expression of the idea-pattern. It is in no sense a substantival entity but rather the creative product of substantival constituents belonging to one or more personalities. Thus what is perceived as a full-blown hallucination is merely the outward expression of a drama; and it is within this drama that elements can be detected which may be able to throw considerable light upon the deeper

strata of human personality and the remarkable power of subconscious activity.

In developing his thesis Mr. Tyrrell is careful to avoid any extravagant suggestions. He relies for his facts upon the best cases to be found in the literature, especially those published in "Phantasms of the Living" and in the *Journal and Proceedings of the Society for Psychical Research*. How far these accounts can be relied upon is for the reader himself to decide. More than sixty years ago Mr. A. T. Innes, in a discussion of "Phantasms of the Living" (1886), pointed out that contemporary letters and documents proving the authenticity of the crisis cases were conspicuous by their absence, and he went so far as to state that of seven hundred miscellaneous cases which he had examined one only was accompanied by a relevant document.

Although perhaps it might have been wiser in this edition to warn the reader regarding the weakness of many of the examples quoted and to have recorded the gist of the Innes-Peirce-Gurney controversies, the book remains the best critical discussion of apparitions that has hitherto appeared. It sweeps away many of the misconceptions so common when discussing 'ghosts', and brings the whole subject into sober perspective so that these very curious phenomena can be fitted (at least partially) into the psychological framework where they undoubtedly belong.

E. J. DINGWALL

LOGIC FOR MODERN SCIENCE

The Logic of Modern Science

By Prof. J. R. Kantor. Pp. xvi + 360. (Bloomington, Indiana: The Principia Press, Inc., 1953.) 6 dollars.

THE principal thesis of this book appears to be that scientific procedures and results have been too much and too unwittingly influenced by cultural institutions. The author, who is a psychologist, therefore proposes to reject all current ontological, epistemological and psychological theories concerning natural science, for these all suffer from the defect of involving what the author calls mentalistic and spiritistic notions which have been introduced not in the interest of science but of theology. But he goes even further than this: he not only rejects Berkeley but also Hume. He wishes, apparently, to reinstate naïve realism in epistemology and to retain a thing-attributed theory in ontology. His psychological theory is his own and is called interbehaviourism to distinguish it from ordinary behaviourism which he rejects. He calls the latter "the end point in the dualistic development we have just sketched". The psychological organism becomes the *body without mind*. The behaviourists, for example, simply deny the necessity of dealing with any psychic factor. The strict behaviourist attempts to interpret all psychic happenings in terms of the operation of the brain and other nervous structures.

"But has the behaviorist disposed of 'mind'? Hardly. He simply throws away one half of the traditional body-mind construction and builds his system on the remainder. In no sense does he extricate himself from the dualistic tradition. What is required is to withdraw completely from historical constructions. We need to start over again. *Inter-behavioral* psychology . . . makes this attempt" (p. 259).

The present reviewer confesses that he has failed to understand interbehavioural psychology from what the author says in this book. Perhaps it is necessary to read the same author's other books on the subject. The most easily understood parts of the present work are naturally the critical parts. These have much that is interesting to say about physics, chemistry, biology, psychology and sociology. After such wholesale destruction anything constructive is bound to be so novel and revolutionary as to be extremely difficult to follow. This difficulty is increased in the present instance by the author's rather loose use of language and the absence of detailed argument showing how the new view overcomes the difficulties with which the older theories attempted to deal.

The word 'logic' is used throughout in a very wide sense, and the few remarks which the author makes about logic in the narrower and stricter sense are rather misleading. Consequently, when the author comes to discuss such questions as: "What is the significance of abstract formal systems for scientific work?" and: "Are scientific laws deduced from the premises of logical systems or constructed from events?" his treatment of these topics (which require a knowledge of logic in the narrower sense) is intuitive and popular rather than analytical and scientific. No mention is made in the extensive bibliography of the work of Carnap, Church, Quine or Tarski among the many who have contributed to these topics in recent years. Similarly, the chapter on mathematics and natural science, which makes no reference to the work of Frege, Whitehead and Russell, Hilbert or Brouwer, scarcely rises above the popular level and gives a very misleading notion of the present state of knowledge.

J. H. WOODGER

VERMUYDEN AND THE FENS

Vermuyden and the Fens

A Study of Sir Cornelius Vermuyden and the Great Level. By L. E. Harris. Pp. 168+8 plates. (London: Cleaver-Hume Press, Ltd., 1953.) 21s. net.

THE draining of the Fenland is one of the most notable enterprises in the history of the English countryside. It was achieved only with much difficulty, and the main architect of that achievement was Cornelius Vermuyden. He was born in 1590 on the island of Tholen in Holland, and moved to England in 1621. He was involved in a number of enterprises; but the greatest, and the one upon which his reputation must rest, was the draining of the great stretch of peat later known as the Bedford Level.

During the latter years of the sixteenth and the early years of the seventeenth century, the possibility of draining this area was hotly debated, and the debate culminated in 1630 in a project headed by Francis, fourth Earl of Bedford. Vermuyden was already interested in the scheme, and, at the request of the Earl, he undertook the direction of the work. Discussion had ranged around two opinions. One held that the existing watercourses should be deepened and embanked; the other, held by Vermuyden, advocated that new and artificial straight cuts be made. So it was in accordance with this second view that the work proceeded. The confusion of the Civil War, and continued hostility to the scheme, interrupted the progress of the work, and it was not

until 1652 that the area was formally declared to be drained. Vermuyden's connexion with the Level appears to have ceased in 1655; and but little is known of his life after this. The date of his death was in doubt, but Mr. Harris has now shown that it was 1677; the record of the burial is in the register of the Church of St. Margaret, Westminster.

The work of Vermuyden, both while it was in progress and afterwards, was surrounded by controversy, and it is true that successive floods, more than once, very nearly brought the scheme to disaster. As one engineer, John Golborne, wrote in 1777: "Look which way you will, you will see nothing but misery and desolation". Neither Vermuyden nor his associates apparently had realized that as soon as the peat was drained, its surface would become lower, and that pumping would be necessary. It is this lowering that has very largely been responsible for the continued flooding of the Fens. Successive engineers bitterly attacked Vermuyden's engineering works on technical grounds, and Mr. Harris guides us with great skill through the many differences of opinion. Moreover, he points out that "the only practical standard of comparison to apply to Vermuyden's work is how the drainage of the Great Level would be carried out to-day, assuming that conditions in, and the state of, the Level were as they existed in the mid-seventeenth century. Would a similar plan be adopted?" It is a difficult question to answer; but the fact is that the new Flood Relief Scheme embodies features that Vermuyden proposed but which were never carried out. Had these been carried out, "his scheme would have proved even more successful than in fact it did". The general professional verdict on Vermuyden's work has "become more favourable", and something of his greatness appreciated.

Amid this story, some light is shed upon Vermuyden himself. He was "a hard man of business", both "dominating and aggressive", certainly litigious. "It is debatable whether Vermuyden could be considered to have been a likeable man." But in making these remarks, Mr. Harris would have us remember that the bitter criticism of his work was certainly unjustified, and that there is no "valid reason why the judgement of success should be withheld from him".

This book not only throws light upon a little-known figure of the seventeenth century, but also is of the first importance to any student of fen draining. It most skilfully handles difficult material, and presents a balanced picture of a man and a problem. It is also attractively written and attractively produced and illustrated.

H. C. DARBY

ORIGIN OF METAMORPHIC ROCKS

The Origin of Metamorphic and Metasomatic Rocks A Treatise on Recrystallization and Replacement in the Earth's Crust. By Prof. Hans Ramberg. Pp. xvii+317. (Chicago: University of Chicago Press; London: Cambridge University Press, 1952.) 75s. net.

THIS interesting book is the latest of several texts, dealing with the origin and formation of crystalline rocks, that have appeared in recent years in the United States. Prof. Ramberg confines himself to the field of metamorphism, though this is viewed

in the broadest terms so that such operations as granitization are included. The sub-title indicates the author's respect for metasomatism as a rock-forming process, a subject with which the last third of the book is largely concerned.

In his opening discussion of some of the principles of thermodynamics and crystal chemistry, Prof. Ramberg bases his analysis of chemical processes in rocks on the concept of free energy. He argues that this is simpler than a discussion of the relations of minerals with a hypothetical pore fluid. He makes a most interesting attempt to compile equilibrium diagrams for metamorphic minerals largely from the data provided by mineral assemblages in the different metamorphic facies. It is considered that such diagrams, even though calculated theoretically from an insufficient number of points, provide the best way we have of presenting the scanty data available on the behaviour of metamorphic minerals under changing pressure-temperature-concentration conditions. The tentative nature of these diagrams is repeatedly pointed out and, provided this is borne in mind, a very promising method of dealing with metamorphic assemblages seems to be developed. An appendix on chemical bonds in crystals is provided as a supplement to these early chapters.

A discussion of the kinetics of metamorphism leads on to the more strictly petrological parts of this book. These make up about two-thirds of the text, and may well, as the author points out, be read first. Here emphasis is put upon the general principles of petrogenesis, while the "collection of erratic data and descriptions of rocks or field relations are kept at a minimum". This quite justifiable treatment requires that the reader must have a general acquaintance with metamorphic rocks. Such a treatment does not mean that field evidence is neglected. On the contrary, one of the most attractive features of the work is the attention paid to what might be called the architecture of the extensive regionally metamorphosed terranes. This is shown in the survey of structural properties of metamorphic rocks and again when the deep-seated quartz-feldspathic rocks are described during the discussion of metasomatism. These sections are illustrated by excellent photographs, most of which were taken by the author during his work in Greenland.

After a short discussion of stress and antistress minerals and the structural survey mentioned already, there comes an account of the mineral facies of metamorphic rocks, with emphasis on the assemblages formed during regional metamorphism (twenty-seven pages) as against those formed during contact metamorphism (two pages). This emphasis is maintained in the treatment of metasomatism and metamorphic differentiation and is no doubt deliberate, for the author is concerned to show the prime importance of regional metamorphism and metasomatism as rock-forming operations.

Metasomatism is recognized as a complex and little understood process. If we accept the author's view that this process is not one in which we can "expect to receive aid from physics and chemistry in the form of laws ready to be applied to our complex problem without many modifications", the lengthy discussion of transfer of matter through rocks must at times seem rather speculative. But unless geologists with the experience of Prof. Ramberg are prepared to expose their views on the subject, we may never get to grips with the question. This discussion is followed by an account of metamorphic differen-

tiation, after which there is the briefest of references to contact metasomatism (twenty lines) and a very relevant excursion into metasomatism in practically unmetamorphosed sediments. It is a pity that these last two topics could not have been treated more fully, for an understanding of such matters would contribute to our comprehension of the regionally metamorphosed schists and quartz-feldspathic gneisses which constitute the major problem. Whether or not one agrees that such rocks are the product of diffusion through the solid, the author must be given credit for setting out so clearly the facts about the occurrence of such rocks in the deeply eroded mountain chains, facts which any hypothesis on deep-seated plutonism must take into account.

H. H. READ

GENETIC CLASSIFICATION IN MINERALOGY

Spezielle Mineralogie auf geochemischer Grundlage Mit einem Anhang: Ein kristallchemisches Mineralsystem. Von Prof. Felix Machatschki. Pp. vii + 378. (Wien: Springer-Verlag, 1953.) 61s. 6d.

ALMOST all text-books on mineralogy have been based on a chemical classification more or less modified by structural considerations; the first subdivision has been into elements, sulphides, oxides, carbonates, silicates, etc., while within each of these divisions the big isomorphous groups of species, such as the rhombohedral carbonates, the feldspars, or the spinels, form natural units. More recently, the developments of structural crystallography have allowed an intermediate division by structurally allied groups such as the island, chain, sheet, and network silicates.

Prof. Machatschki has experimented with a quite distinct method of classification—a genetic one. Followed strictly, this approach would lead to the dispersal of many familiar groups of structurally and chemically allied species such as the pyroxenes; this and other considerations have deterred him from following his idea to its logical conclusion, and some readers may feel that this division of aim detracts from the unity of the book. But all should find the novel approach stimulating, and the book should prove a very valuable addition to the bookshelf of mineralogists and petrologists alike. It is difficult to decide at a first reading how far the divided aim will prove of serious detriment; but of the value of many features of the book there can be no doubt.

After a short introduction Prof. Machatschki deals with the primary magmatic minerals in order of crystallization, then with pegmatitic-pneumatolytic, hydrothermal, and solfataric minerals. The second section deals with clays, lateritic minerals, and other weathering products, evaporites, and minerals of organic origin, and the third with the minerals of metamorphic rocks. A great many minerals would fall into more than one of these headings and many familiar mineral families would be scattered over several headings; so each well-known family is discussed in detail at the earliest point in this genetic development where any member of the family is encountered. The ore minerals are treated exceptionally; instead of being dealt with as they are met in the logical genetic series, their detailed descriptions are all collected in a special section, arranged

under metals, with particular attention to the rarer metals. A rather similar and very useful arrangement is adopted for the pegmatitic-pneumatolytic minerals, which are divided into lithium, rubidium-caesium, beryllium, boron, etc., minerals.

As an appendix, a strictly crystallochemical classification is attempted, which may be of value in disclosing some unexpected structural similarities.

The chemical formulae for the species are a feature to which Prof. Machatschki has given special attention. He indicates the co-ordination of the principal atoms or groups by bracketed superscript numbers (for example, $\text{Si}^{(4)}$, $\text{Al}^{(4)}$), and encloses polyatomic anions with homopolar or largely homopolar links in square brackets (for example, $[\text{SO}_4]$, $[(\text{Si}, \text{Al})\text{O}_4]$); structures based on homopolar-linked chains, sheets, or networks are prefixed ∞^1 , ∞^2 , and ∞^3 respectively, while the chemical formula is followed by a letter or pair of letters symbolizing the system of crystallization. These features should prove very useful in giving a condensed picture of the principal structural features.

There are few errors or omissions of consequence, though some rare minerals are unexpectedly included and more common ones omitted (for example, the very rare edingtonite is included, and incorrectly stated to be related to scolecite, while the much commoner mordenite is omitted; and mesolite is a definite compound, not a mixed-crystal).

M. H. HEY

CLAY MINERALS

Clay Mineralogy

By Prof. Ralph E. Grim. (McGraw-Hill Series in Geology.) Pp. xli+384. (London: McGraw-Hill Publishing Company, 1953.) 6s. 6d.

THE extent of the interest in clay minerals is very wide, as Prof. Grim points out in the introduction to his excellent book, ranging as it does from the earliest of human industries—pottery making and agriculture—down to the cracking of oils in modern refineries. Physical and physicochemical studies carried out by many workers over the past hundred years had provided a considerable insight into the properties of clays; but it was not until Hadding's discovery of their crystallinity that a more fundamental attack on the subject was possible. The adumbration by Goldschmidt and Pauling of the laws of crystal chemistry and their application by C. E. Marshall to minerals like montmorillonite made further advances possible. While much has been learned about clay minerals in the relatively pure state, much remains to be done on the complex mixtures that occur in such materials as soils and sediments. The quantitative aspects of such mixtures still bristle with difficulties that will not easily be overcome.

As in other aspects of mineralogy, misidentification and duplication of names has proved troublesome; but in his discussion of this Prof. Grim surely goes too far in relegating beidellite to the ranks of discredited species. Attapulgate would be a more appropriate candidate, for all the evidence points to the identity of this and palygorskite, which has a very long-standing priority. Recent work has certainly shown the advisability of checking all identifications by X-rays, otherwise much work can be completely vitiated.

Appropriately, the main part of the book begins with a good account of the structures of the various clay minerals, with tabulated data taken largely from the Clay Mineral Group's monograph. The latter will, however, still be essential to anyone wishing to use X-ray techniques, for in a general text it is obviously impossible to cover every aspect of the work and discuss the many difficulties that arise in the interpretation of X-ray diffraction patterns of clay materials.

Successive chapters then deal with electron micrograph studies on shape and size, and with ion exchange. In this last Prof. Grim seems out of his element, but it is an adequate account. In marked contrast are the chapters on the clay-water system and the effect of heating on clays, in which the author is dealing with aspects to which he has contributed much, and both are very thoroughly treated. Reactions with organic substances, which come next, have proved extremely valuable both in connexion with the properties of the clay minerals and their identification, but also in opening up the possibility of studying the organic molecules taking part. This has obvious bearings on the reactions between soil organic matter and clays and in particular the apparent inactivation of certain types of substances with regard to biological decomposition. Chapters on the optical properties of clay minerals and miscellaneous properties (solubility, infra-red spectra, etc.) complete what one might call the laboratory side. In the last two chapters Prof. Grim deals very thoroughly with the origin and formation of clay minerals as far as the data will allow. Many more field data are required before one can obtain a clear picture of clay mineral formation in many cases. One would have hoped that something like an 'inverse' Bowen reaction series might have held good for the natural synthesis of clay minerals, but there seem to be too many exceptions.

In a book covering such a broad field it would be easy to find fault on particular points, especially since the subject is developing so rapidly. The book is well documented both in footnotes and supplementary bibliographies in each chapter, and it can be thoroughly recommended.

A. MURR

GEOLOGY AND SCENERY

Geology and Scenery in Britain

By T. G. Miller. Pp. 224+31 plates. (London: B. T. Batsford, Ltd., 1953.) 18s. net.

IN writing a work dealing with the correlation between the geological make-up and scenery of Britain, the author has chosen to enter a highly competitive field of geological literature. Personally, I doubt the need for any further addition to it, unless the aim is to go beyond and into the dependence upon the outward expression of the rocky skeleton of the country of the organic population and its manifold activities. Were such a subject the main theme of this book, it might well claim some novelty, and indeed in the introduction we are promised more of this than eventually materializes. The author sets out to produce a compromise between the 'country book' and the technical regional survey, the whole to be comprehensible to the layman with a love of the countryside. The balance is far from lying midway between the two and in fact lies heavily towards the

regional survey, in which case it becomes justifiable to compare it with similar productions. It also appears that Britain comprises England and Wales only, so that the scope of the book becomes identical with Sir Arthur Trueman's "Geology and Scenery in England and Wales". Since the latter is available for half-a-crown, Mr. Miller sets himself a task of no inconsiderable magnitude in crashing into the market.

On the whole he has produced a readable volume and in places displays astonishing lucidity. What is said is said in a concise manner, and most geologists would appreciate the deftness with which the author disposes of masses of detail; but I think that the layman would appreciate a sacrifice of some of the subject-matter and a fuller, if more cumbersome, exposition of a well-selected residuum. Mr. Miller has used this technique in his useful diagrams. Why not in the text? The pithiness of certain sections of the early chapters dealing with the fundamental principles of geological science is admirable, but there is a tendency for certain short asides and summaries to miss the point in an irritating manner. This phenomenon of just missing the target applies also to some of the quotations used as chapter headings. Thus I do not think that the conflict between Man and Nature can be summed up as "dubious neutrality" (p. 22) on the part of the former, or that a quotation involving "the mountains far away" (p. 73) is an appropriate introduction to a chapter on the older rocks of Wales. Bacon's conception of the earth (p. 19) does not harmonize with the geologist's approach and stands in marked contrast to the subject-matter of the chapter which it introduces. If quotations are not apt they ought not to be used.

The volume includes some very fine plates illustrating scenery and structures. One might protest against foreign views being included in a work on British scenery were it not for the fact that they are among the best in the book. The Persian photographs especially are wonderful. The references to Plate 30 on page 76 and to Plate 31 on page 81 should be interchanged.

The author has produced a painstaking review of his subject; he can write well and I am glad to have his work on my shelves. Even so, if one is limited to a single volume on this topic, there are better works already available. FRANK HODSON

THE EARLY DAYS OF AGRICULTURE

Plough and Pasture

The Early History of Farming. Part 1: Prehistoric Farming of Europe and the Near East. By E. Cecil Curwen. Part 2: Farming of Non-European Peoples. By Gudmund Hatt. Pp. xii+329+14 plates. (New York: Henry Schuman, Inc., 1953.) 5 dollars.

AGRICULTURE has been practised for some six or seven thousand years; but its written records go back for only about one-third of this time. Fortunately, modern archaeologists have been able to unravel a great deal of the earlier history and it is now possible to draw up a much more extensive account than was practicable a generation ago.

Mr. Curwen and Prof. Hatt have summarized much of this new knowledge, but instead of writing one book jointly Mr. Curwen has in one section described the prehistoric farming of Europe and the Near East, while in the other section Prof. Hatt deals with the farming of non-European countries.

Mr. Curwen, who is already well known for his writings on Sussex archaeology, starts with the primitive food-gathering stage of human history, and shows how the gradual drying of the climate in the eastern Mediterranean and Near East curtailed the range of operations. Mankind then split into two groups. One tended to settle in the river valleys and well-watered oases where its members cultivated some of the wild grasses; the other group remained nomadic but could no longer rely on hunting and food gathering; instead they domesticated certain animals and became pastoralists, wandering from one set of grazing lands to another, at first indiscriminately, but later kept to a regular sequence of dry and wet season pastures, each tribe having its own particular lands. Gradually the settled agriculturists developed the arts of civilization, the sciences and the practical activities: they became inventors, traders and ultimately industrialists; the pastoral peoples on the other hand tended to become more contemplative and developed religions, poetry and the mystical arts. Mr. Curwen shows how the ancient traditions of Egypt, Greece, and Palestine as expressed in the Old Testament agree in placing the origin of this dichotomy of races in an area bounded on the west by the river Nile, on the east by the river Indus, and on the north by about the forty-fifth parallel. The period in time was the end of the Mesolithic and the beginning of the Neolithic age.

The early history of the cultivated cereals, the domesticated animals and the implements is given in some detail; the account of the plough, however, should be read in conjunction with F. G. Payne's studies on this subject. It is remarkable that the number of kinds of plants and animals used as food has decreased since the early food-gathering days and that very few additions have been made to the list of common foods with the exception of migrants such as potatoes and maize, which, however, had been used from very early times in their respective countries of origin.

English readers will welcome the opportunity of reading the account by Prof. Gudmund Hatt, of the University of Copenhagen, of the development of agriculture in countries outside Europe and the Middle East. He begins with accounts of food gathering in the Americas, Australia and Africa, and describes some of the protective magic associated with it. The "symbiosis between man and plants" and the "religious fear of wronging the food plant", to quote the author's phrases, gradually developed into agriculture which doubtless originated independently in the different continents, for the human migrations had taken place long before it occurred. The earliest stage was a combination of hunting by the man and a rudimentary agriculture practised by the women using digging sticks. This semi-agriculture gradually developed into full agriculture using implements drawn by animals directed by men. Roots—yams, cassava and others—played a larger part than in Europe; maize seems to have come late into North America. The Kentucky caves give evidence of the cultivation of sunflowers, goosefoot (*Thenopodium*), a pumpkin (*Cucurbita pepo*) and a gourd (*Lagenaria siceraria*) long before pottery was known or maize or

beans grown: curiously enough the gourd seems to have been of Old World origin. Tobacco culture was widespread in America even among tribes that did not grow food. It is unknown whence or how maize came into cultivation, but its arrival was a turning point in American history, for it made possible the magnificent cultural evolution in the Andes and in Central America, Mexico and the south-west area. Wherever it came from, Colombia appears to be its oldest centre of cultivation. Colombia also appears as the centre of origin of a number of other cultivated plants.

The book contains a large amount of information that will be new to many readers and which, moreover, is not generally accessible. It can be commended to all who are interested in the origins and early history of our domesticated animals and field crops, and in the tools men used for dealing with them.

E. JOHN RUSSELL

THE SOILS OF EUROPE

The Soils of Europe

Illustrated Diagnosis and Systematics. By Prof. Dr. Walter L. Kubiëna. Pp. 318+26 plates. (Madrid: Consejo Superior de Investigaciones Científicas; London: Thomas Murby and Co., 1953.) n.p.

UNTIL the identity of a creature can be established and communicated, correlation and the transfer of experience are impossible and knowledge remains chaotic. The recognition and precise description of kinds of plants and animals by such men as Turner and Geener in the sixteenth century provided the essential foundation for modern biological science; and as a pedologist Dr. Kubiëna is surely right in asserting the urgency of his aim in this book, which "is an attempt to make it possible to identify and to give suitable names to soils for all who need it". Descriptions of 173 different "formations of soils" are illustrated by more than fifty excellent reproductions of beautifully executed paintings chosen in preference to photographs to emphasize the features regarded as most significant. Keys are provided to facilitate rapid identifications which may then be checked by the more-or-less detailed profile descriptions. Many synonyms are carefully equated in the explanation of more than four hundred soil names and some two hundred pedological terms. Dr. Kubiëna claims to have studied personally most of the soils described, and it may well be doubted if any other person could provide such an extensive background of personal experience. It is a pity that in this translation from the German such a valuable book should be marred by English so often ambiguous that the reader is left doubting those subtleties which may well have been intended; and from the number of typographic errors it seems doubtful whether the proofs could ever have been read at all.

The development of a precise terminology, a clear and concise nomenclature, and an orderly and serviceable classification are probably the three most urgent requirements in the study of the soil. In the field of profile description Dr. Kubiëna is particularly helpful in those features of the profile which reveal themselves best under the microscope. His account of both the morphology and genesis of the various forms of organic matter establishes without question the value of his techniques, while the features upon

which he bases his important distinction between *Lohm* and *Erde* could scarcely be fully discerned by the unaided senses. Many of the profile descriptions, however, are quite inadequate for precise diagnosis, and some of the more obvious features, such as major profile structures, for example, are often not described at all.

In nomenclature, Dr. Kubiëna adopts a Linnæan approach, and perhaps assumes too readily that the success of a system for plants and animals is a guarantee of its value in soils. Indeed, in his assumption that soils may be "as exactly and unambiguously characterized and named as breeds of cereals, market garden crops, and domestic animals" Dr. Kubiëna is assuming an analogy which is misleading. Plants and animals are discrete and transferable units with their essential characters determined by an internal mechanism, whereas soils, as Dokuchaiev insisted, "are a mere function of the soil-forming factors". As in petrology, the essential problem is the significant division of a gradually varying continuum, and it may be that a premature enthusiasm for "pigeon-holing" may divert energies from the more vital study of soil and landscape relationships. That Dr. Kubiëna is himself aware of the merging of soil boundaries is clear from his emphasis on the strongly dynamic nature of soil profiles; and his evolutionary division between raw soils, ranker soils, and more mature soils recognizes, at a high level in his classification, profile development sequences similar to those which have been shown to be of such practical value in New Zealand. To arrange soils in order from the simplest to the most complex, after consideration of "all essential characteristics", is a logical aim, but its adequate fulfilment will require much more knowledge of profile dynamics than we now possess.

The book is stimulating and of lasting value, and cannot be neglected by any serious student of the soil.

E. CROMPTON

ELECTRONIC THEORY OF VALENCY IN ORGANIC CHEMISTRY

Electron Structures of Organic Molecules

By Prof. Lloyd N. Ferguson. Pp. xi+335. (London: Constable and Co., Ltd., 1952.) 48s. net.

THE scope of this book is correctly described in its title. As is explained in the introductory chapter, it gives an up-to-date account of that part of physical organic chemistry which is concerned with molecules in their normal (non-reacting) states. Successive chapters carry the following headings: the types of chemical bonds, the polar nature of covalent bonds, covalent bond distances and bond angles, intramolecular forces, induction and electric dipole moments, magnetic susceptibility, resonance and its applications in organic chemistry, absorption spectroscopy (this chapter and the preceding one occupy almost half the book), aromatic substitution, and molecular and electron structures by physical methods.

The treatment is clear and the expositions generally full, so that the book is interesting to read and should be easily followed by the honours degree student for whom it seems to have been designed. Yet a conscientious teacher might hesitate before recommending the book without qualification—especially as it is so expensive.

Misprints occur in all books, and in this one not oftener than the average; but the erroneous formula for picryl iodide on p. 174 and the mistake in equation (8) on p. 220 are examples of rather serious slips. What is much more serious is that the writing abounds in loose phraseology such as, "the four valencies of a carbon atom form a tetrahedron" (p. 89), or the "equation ($A = A_{\text{sol}}^+ + e^-$) is the electrode potential" (p. 70). Again, to write of associated compounds on p. 65 that the "association increases the solubility in water" is surely to suggest a false causality. In a single paragraph on p. 80 the phrase "degree of association" is used in two distinctly different senses. Furthermore there are some misleading statements: "the chief use (of X-rays) to organic chemists has been with crystalline powders" (p. 82), and "electron diffraction is the principal type of diffraction studies being made now" (p. 83) are opinions that could not long survive a glance at any recent volume of the "Structure Reports". In several places (for example, pp. 22, 144, 159) the expert reader will gain the impression that the molecular orbital treatment is merely a part of the resonance concept, instead of being an alternative and independent method of approximation.

When another American author has written of "the electronic theory of the English school", it is surprising to find the names of Ingold, Lapworth, Robinson and Sidgwick together accounting for only 14 entries in Prof. Ferguson's author-index, while several Californian or mid-Western authorities individually exceed this total. (On the other hand, two well-known American workers appear as "R. B. Core" and "J. Donahue" in both text and index.)

Most of these defects are superficial and could be easily remedied, and to have pointed them out at this length is to have emphasized them unduly unless it is also emphasized that this book has many virtues. A large quantity of current information is brought together in a useful way, and offered in a readable form. Those able to read the book with judgment will find it valuable. After every few pages there is a list of books and review articles for supplementary reading. These lists are up to date and well chosen; and they are by no means confined to American publications. With due safeguards, this book should be made accessible to advanced students of chemistry; it can be recommended to any of their seniors who may be concerned with physical organic chemistry.

J. O. SPEAKMAN

variables are involved and a vast amount of work remains to be done. This has become even more evident since the comparatively recent discovery of the phenomenon of cocatalysis and the fact that the true chain initiators may be complexes between catalyst and trace impurities, solvent, or even monomer.

In this present state of the subject a normal type book would be premature. I believe, however, that Dr. Plesch has succeeded in the present volume in satisfying the intense interest in the subject by producing what is in effect a progress report by the most eminent workers in the field. There is reported here, with copious references to earlier work, a good deal of representative material which has been published in recent years together with some which will shortly appear. Most valuable of all, however, are the comments and suggestions made in discussion. The whole has been arranged, presented, and printed in a most attractive and readable fashion.

After a foreword by Sir Eric Rideal, the preface by Dr. Plesch gives a historical survey and puts the later discussion in perspective by showing in particular the economic and industrial aspects of the subject and also its relationships to modern theories of organic chemistry. Thereafter the book is divided into two main sections approximately equal in length. The first is devoted entirely to papers on complex formation with a direct bearing on the initiation process, while the second includes papers on the polymerization process itself. These are summarized by Prof. D. D. Eley and Prof. F. S. Dainton respectively.

Adverse comment is of a trivial nature and detracts not at all from the value of the book. It is concerned only with minor points of inconsistency in presentation. For example, Ph and C_6H_5 are used, even in the same equation (p. 76), to represent the phenyl group and the appearance in the text sometimes of [] while at other times "the concentration of" is written in full. These points may be rather difficult to avoid, however, in a publication of this nature where the original material has come from a number of authors.

This book gives an authoritative account of the state of our knowledge of cationic polymerization at March 1952. It is of particular value to all interested in the general fields of high polymers and complex formation and must be indispensable to workers in the more restricted field which it covers.

N. GRASSIE

CATIONIC POLYMERIZATION

Cationic Polymerization and Related Complexes

Edited by Dr. P. H. Plesch. (Proceedings of a Conference held at the University College of North Staffordshire, 24th-26th March, 1952.) Pp. xii+166. (Cambridge: W. Heffer and Sons, Ltd., 1953.) 20s.

THE experimental investigation of cationic polymerization was initiated in the early 1930's, as Dr. Plesch points out in his most admirable preface to this book, when it was recognized as a distinct type of polymerization reaction by reason of the fact that it could not be fitted into the general theory of free-radical chain reactions. Since that time, spectacular advances have been made in the understanding of the fundamental nature of the reaction. While a fair measure of agreement on general detail has been reached it is quite clear that a very large number of

TECHNIQUE OF ORGANIC CHEMISTRY

Technique of Organic Chemistry

Vol. 8: Investigation of Rates and Mechanisms of Reactions. S. L. Friess and A. Weissberger (Editors). Pp. xxiii+760. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1953.) 12.50 dollars.

THIS volume surveys the broad domain of chemical kinetics. The editors have sought to present theoretical as well as practical techniques, and topics outside the scope of formal kinetics are treated when relevant to the problems of reaction mechanism. The initial chapters are relatively general and are devoted to the theory of chemical kinetics, to experimental methods of measuring

reaction-rates, and to the principles underlying the elucidation of mechanism: later chapters are more specialized and refer to gas-phase reactions, liquid-phase reactions (and homogeneous catalysis), polymerization and polymer reactions, biological reactions, and very fast reactions. Heterogeneous reactions, heterogeneous catalysis and other bi-phase processes are not treated.

Viewed as a whole this is unquestionably a useful source-book for chemists whose interests lie within or on the fringe of the field of reaction mechanism. The least successful aspects are the purely theoretical parts, for the absolute rate theory which is the natural foundation of the main sections of the book is very summarily presented, the degree of condensation being such that in some respects the foundation is insecure. For example, in the discussion of the effect of isotopic substitution (p. 26) it is claimed that, a C—H bond being replaced by C—D, the *maximum* theoretical ratio of rate constants is 4.3. Actually, the author has calculated (approximately) the 'maximum' velocity ratio for a special, and certainly very rare, case in which the deformation vibrations have the same frequency in the ground and transition states; but none of this is explained. Probably no one will be misled, but it is disturbing to find several references to this 'derivation' at points later in the book.

The field covered in this volume is broad and correspondingly difficult to survey; but the authors have maintained in general a very even and interesting level. In a treatise on the methods of organic chemistry it is natural that liquid systems receive the most attention; but not the least useful sections are devoted to the theory and practice of relatively specialized techniques: for example, flow methods, which are becoming increasingly popular. It may, perhaps, be regretted that the section on rapid reactions is restricted to biochemical systems or to systems primarily of biochemical interest: no account is given of the investigation by ultrasonic and other new methods of simple, very fast reactions in the gas phase.

Binding and presentation conform to the high standard of the series, and a cumulative index to the earlier volumes is provided. J. C. D. BRAND

RUSSIAN PROGRESS IN ELECTRON DIFFRACTION

Electron Diffraction

By Prof. Z. G. Pinsker. Translated by J. A. Spink and E. Feigl. Pp. xiv + 443 + 25 plates. (London: Butterworths Scientific Publications, Ltd., 1953.) 63s. net.

THE appearance of a translation of this important Russian book is very welcome. A specially contributed preface by the author suggests that Russian scientists are anxious for international co-operation, and this would be greatly helped by the appearance of further translations of this kind.

As an orthodox work on the theory and practice of electron diffraction, the book is very good; it deals with the elements of wave theory, the diffraction of waves by crystals, experimental methods, apparatus, and practical results. The chapters on the last subject appear to deal fairly with Russian and non-Russian contributions, and it is evident that, in

some types of electron-diffraction work, the Russians are well ahead. This is particularly true of crystal-structure determination; since electrons are scattered by the field within an atom and not by electron density, hydrogen atoms are more easily detected by electrons than by X-rays, and work on this subject has been appearing in the Russian literature since 1948. As far as the reviewer is aware, the earliest comparable work in English is that of Cowley in Australia, published in 1953.

As a historical commentary, however, the book has several defects. For example, the discovery of electron diffraction is attributed solely to Davisson and Germer, Thomson's work being referred to, only incidentally, several pages later. Quite naturally, Russian work receives predominant attention; but it comes as a shock to find W. L. Bragg given only minor honours for what is usually known as Bragg's law; Prof. Pinsker consistently refers to this law as the Wulff-Bragg law, claiming that it was discovered by "the Russian scientist Wulff (*Phys. Z.*, 14, 217; 1913) and simultaneously Bragg (*Proc. Camb. Phil. Soc.*, 17, 43; 1912)".

This claim deserves some attention, since simultaneity can be claimed only if the later paper were received before the earlier one was published. In this instance, this is not so; Bragg's paper was published in November 1912, and Wulff's was not received until February 1913. Moreover, Wulff's idea arose out of a note published by Bragg in *Nature*, in December 1912, to which Wulff refers in his paper. Thus the claim for a division of the honours cannot be substantiated, even though Wulff was clearly unfortunate in that Bragg's paper was published in a journal which was probably not well known to him.

The translation has been carried out extremely competently, even if the English is inclined to be a little stilted in parts. The translators have added to the value of the book by including many extra references, and the author has contributed some recent Russian ones in his preface.

The book can be confidently recommended as an important work on the subject. H. LIPSON

RADIOACTIVE ISOTOPES

Radioactive Isotopes

An Introduction to their Preparation, Measurement and Use. By W. J. Whitehouse and J. L. Putman. Pp. xvi + 424 + 6 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1953.) 50s. net.

DURING the past decade the number of applications of radioactive isotopes has increased enormously, and the concomitant growth of interest has created a demand for appropriate text-books. For those who wish to read about the preparation of radioactive isotopes, their properties and uses, "Radioactive Isotopes" constitutes an excellent survey. The treatment is comprehensive and well balanced and the presentation generally lucid and precise: furthermore, the book arouses and maintains interest.

After a brief survey of the nuclear reactions which are used in the production of radioactive isotopes, the modes of nuclear disintegration are discussed together with the properties of the radiations. These topics occupy about a quarter of the book and they constitute the background for the remainder of the text. The authors then deal with the practical

production of isotopes in uranium piles and cyclotrons, and the reader is given a clear description of the requirements for these processes. More stress might have been laid, however, on the high specific activities produced by the Sillard-Chalmers effect.

The chapter on the detection and measurement of the radiations includes sections on units, Geiger counters of various types, proportional and scintillation counters. Absolute and relative counting are both considered and a section is devoted to the statistics of counting experiments. Adequate reference is made, for example, to the comparison of radioactive sources under exactly similar conditions. It is a pity that occasionally one is left in doubt about the exact scope and limitation of a few of the counting methods. The addition of more numerical examples, here and elsewhere, would add greatly to the value of the book.

The authors describe the gross effect of the radiations, the production of ionization and the physical and chemical consequences. Dose units and dose rates from various sources, ionization chambers, electrometers, and calorimeters are discussed. The chemical aspects are dealt with very briefly.

The treatment of the applications of radioactivity lays stress on the principles and validity of the methods. The radioactive isotopes and their compounds can be used as markers, tracers and sources of radiation, and illustrative examples are widely chosen from physics, chemistry, biology, medicine and industry: sound advice is offered on the design of experiments. The book finishes with a description of manipulation techniques and hazards, and a useful table of many radioactive isotopes.

The index would be improved by including some of the more common isotopes. Throughout the book, graphs and formulae have been presented in useful forms, and many references are made to original papers, reviews and books: readers who wish to translate the written word into action will find valuable information in this book, though those who are not physicists might appreciate more information on the characteristics of the ideal electronic equipment to be used in conjunction with radioactive isotopes. This would enable an experimenter to assess the power packs, amplifiers, scalars and other equipment available commercially.

In spite of these minor criticisms, the book can be thoroughly recommended. S. J. THOMSON

DISCHARGES IN GASES

Electrical Breakdown of Gases

By J. M. Meek and J. D. Craggs. (International Series of Monographs on Physics.) Pp. ix + 607. (Oxford: At the Clarendon Press; London: Oxford University Press, 1953.) 60s. net.

SIR JOHN TOWNSEND advanced his theory of ionization by collision in 1900 and his theory of the unstable discharge in 1903 (in *The Electrician*). The brilliant researches he afterwards conducted and described in his 1915 book "Electricity in Gases" gave most readers the impression that the fundamental theory of discharges was known and that it remained but to apply it. After 1920 this optimism disappeared mainly because the principles of the interactions between electrons, ions, molecules, radiation and solid surfaces were incompletely known and because the range of possible conditions permits a remarkable proliferation of phenomena. The great

volume of research undertaken since then provided a vast quantity of observed data, greatly improved experimental methods and valuable deductions within limited fields, but the general theory did not greatly advance. Since the Second World War, it has come to be appreciated that Townsend had the roots of the matter and that, with the aid of contemporary advances in physics, workers on discharges can begin to see the complete tree.

Prof. Meek has for long been one of the foremost contributors to the subject, at first with Dr. T. E. Allibone, then with Prof. L. B. Loeb and now with the school he founded himself at Liverpool, in which Dr. Craggs plays a leading part. The authors of "Electrical Breakdown of Gases" are thus essentially qualified for their task of summarizing knowledge of unstable conduction in gases. Their book is as complete as its five hundred pages and profuse, and often beautiful, illustrations allow. It is highly compressed and its twelve chapters have impressive bibliographies. One can only hint at its scope. The first five chapters give the principles of ionic motion, the mechanisms of ionization and recombination, and the concept of the two Townsend ionization coefficients which together can multiply the ionization into an avalanche and can make the discharge self-maintaining. In the light of these principles the behaviour is discussed of discharges at low pressures, then the corona and the spark at higher pressures, where they are distinct phenomena, and finally the lightning discharge, which is the leading example of the long spark caused by a transient voltage. Chapter 6 essays a quantitative theory of the spark based mainly on the streamer and radial-field hypothesis. Chapter 7 deals with the numerical sparkover voltages in cases of practical importance, including the uniform field, the sphere gap and concentric cylinders. Chapters 8, 9 and 11 cover studies ancillary to or somewhat removed from the main analysis, namely, the influence of ionizing radiations, discharges at high frequency and electrode effects. Chapter 10 considers the detailed structure of the actual spark channel as obtained by recent experimental techniques and relates it to theory. The final chapter deals with the important problem of the transitions from the high-resistance glow to the low-resistance arc condition, which may occur in time or in space. Throughout the book reference is made to important engineering and scientific applications at points where the principle discussed is that which determines the application.

The appendix on recent developments might be thought to support a criticism that the authors should have waited to see whether current work is ultimately successful in simplifying some explanations, for example, the direct application of Townsend's equations by Prof. Llewellyn Jones. On the other hand, any later simplification would be offset by the discovery of new phenomena and a valuable and necessary book would stay unwritten. Similarly, though some may think the authors take rather an individual point of view on controversial issues, such as the streamer theory, yet they refer to those who disagree with them, so that the reader can examine the literature and decide for himself. If books are to be written by those who are building up the subjects they treat, then such books must necessarily reflect the original research of their authors. Prof. Meek and Dr. Craggs have written a book which every physicist or engineer interested in gaseous discharges should not merely read but should always consult. S. WHITEHEAD

NUCLEAR REACTOR THEORY

The Elements of Nuclear Reactor Theory

By Samuel Glasstone and Milton C. Edlund. Pp. vii+410. (London: Macmillan and Co., Ltd., n.d.) 35s. net.

SOME of the results of the research and development which were necessary in order to produce the atomic bomb have gradually been made available in scientific journals and in the well-organized volumes of the National Nuclear Energy Series. Hitherto, however, no comprehensive account has been given of the theoretical work underlying the design and operation of nuclear reactors. With the current interest in the utilization of atomic power and the establishment of a nuclear reactor as a valuable fundamental research tool, such a book is long overdue.

Dr. Glasstone and Mr. Edlund have most ably filled the gap with their recent book on nuclear reactor theory. This book is based on a course of lectures which is given at the Oak Ridge National Laboratories for graduates who are commencing work on the reactor research and development programme. As such it is written primarily for physicists and engineers but is of interest to all concerned with reactor design.

For those unfamiliar with the properties of neutrons and their interaction with matter four introductory chapters are provided. These deal with such fundamental concepts as nuclear structures, binding energy, energy-levels, cross-sections and radioactivity, culminating in a discussion of the fission process and a chain reaction. The book is restricted, on security grounds, to a discussion of 'thermal' reactors, which are reactors in which the majority of fissions are caused by neutrons the average kinetic energy of which is approximately equal to that of the atoms and molecules in the containing medium.

This introduction is followed by a detailed mathematical treatment of the behaviour of neutrons in matter. The slowing down of fast neutrons from fission is developed according to Fermi's continuous loss of energy model and their subsequent behaviour according to diffusion theory. The application of this work to the design and properties of homogeneous and heterogeneous reactors is given in two later chapters. A discussion on reflectors includes an indication of the value of the group diffusion method for describing the slowing down of neutrons. This is also considered in a chapter on the general theory of homogeneous multiplying systems.

It is gratifying to find that the authors have found space for this chapter and also for one dealing with the relation between diffusion theory and the more exact transport theory. Such considerations are essential in order to understand in what circumstances the simple treatment given earlier becomes invalid.

There are also separate chapters devoted to reactor kinetics, reactor control and perturbation theory. The effects of control rods and delayed neutrons are calculated, and brief mention is made of the effects of fission products and variation of reactor temperature. It is a pity that space could not be found for a discussion of the use of perturbation theory in treating the two latter effects, which are of considerable practical importance.

A comprehensive subject-index is provided, and at the end of each chapter there are several problems which are of practical interest. Sufficient declassified data are given for the reader to design reactors for himself and to determine their operating characteristics.

Some scarcity of references is understandable in a book which is produced under security restrictions, but more references to experimental work which has been published might have been made.

This book can, however, be thoroughly recommended to those who are interested in reactors and wish to know more about their design, to those who are joining a reactor project for the first time and as a reference book to those who have managed without one for so long. P. W. MUMFERY

RECENT RESEARCHES IN PHYSICS

Reports on Progress In Physics

Vol. 16 (1953). Executive Editor: A. C. Stickland. Pp. iv+407. (London: The Physical Society, 1953.) 50s. net; to Fellows, 27s 6d. net.

THIS, the sixteenth in the series of now annual reports, differs little in outward form from its predecessor. As in Vol. 15 there are nine articles each dealing with advances in a particular field or branch of physics. The standard is high and the reports contrive to get more and more specialized. No longer can the physicist of average attainment or the specialist in a particular branch hope to gain easily by reading these reports an insight into interesting developments outside his present knowledge. The authors assume that their readers have more than a nodding acquaintance with their subjects, and they do not bother to give an adequate introduction or to explain fully and simply the terminology and methods used. Far too many aspects are covered in the one article, and it is obvious from the large number of references which accompany each report that only a few lines of text can be devoted to the work described in each of the papers referred to. Authors of future reports might be invited to provide more background material and to deal more broadly but critically with the important advances in the fields they choose to survey.

The present interest in solid-state physics is reflected by the comparatively large number of reports, five of the nine, dealing with various aspects of crystal and solid properties. The first, which is also the longest article in the volume, is by G. E. Bacon and K. Lonsdale and is devoted to a review of the application of neutron diffraction methods to the examination of the structure of solids. Now that neutron beams of considerable intensity are available from atomic piles, progress in the study of the interaction of neutrons with matter has been rapid in recent years. The report deals in particular with the way in which neutron diffraction has been used to supplement studies by X-ray diffraction, and with structural investigations involving light elements, distinctions between atoms of closely similar atomic number, and studies of magnetic materials.

The relation between the magnetic, optical, piezoelectric and elastic properties of crystals and their structural characters is discussed in a brief report by W. A. Wooster. This is a difficult subject and the experimental data are still inadequate, particularly in reference to the elastic constants, to justify more than broad generalizations. Dr. Wooster deals adequately with the material available. An admirable summary of work done mainly during the past five years on the Raman effect is given in the next report by A. C. Menzies. It is fitting that an article on this

effect should be included in the present volume because the twenty-fifth anniversary of the discovery of the effect by Sir C. V. Raman, who originally used sunlight and complementary filters, occurred last year. Appended to the report is an excellent bibliography which is self-explanatory and largely supplements the text of the article. An attempt is made to provide those not closely engaged in Raman work with a summary of early investigations and with definitions of the technical terms used. A brief statement of what the Raman effect is would perhaps also have been useful.

A report of considerable value, probably the first comprehensive report on the subject, is contributed by B. Bleaney and K. W. H. Stevens, of the Clarendon Laboratory, Oxford. It deals with paramagnetic resonance or the electronic magnetic resonance of loosely coupled systems. The experimental techniques and theory are explained, and mainly only those particular aspects of paramagnetic resonance which are well understood are discussed. A close study of the subject and allied topics has been made by the Oxford group of workers under the supervision of Dr. Bleaney, and the authors of the report give an impartial and authoritative description of what has so far been achieved. However, the mathematical relationships look extremely formidable and it is also difficult for the reader to appreciate what is the real importance and significance of the mass of data, both experimental and theoretical, that is being accumulated.

The final article in the group on solid-state physics is entitled "Semiconductor Circuit Elements" and is written by J. S. Blakemore, of Standard Telecommunications Laboratories, Ltd., and A. E. De Barr and J. B. Gunn, of Elliott Brothers (London), Ltd., Research Laboratories. In spite of its title only a small portion of the report is devoted to the technological applications of semiconductors in the form of diodes, photocells and counters, transistors and other circuit elements. The remainder consists of an excellent, concise treatment, using statistics and band theory, of the electron physics of metals, semiconductors and rectification at metal-semiconductor contacts and *p-n* junctions, followed by an informative discussion of the bulk properties of semiconductors.

Five pages of references accompany the forty-three page article on electrical discharges by F. Llewellyn Jones. Recent developments are surveyed under the main headings of the electrical breakdown of gases in static fields; high-frequency discharges; cold electron emission in discharges; and the régime of space charges. This report supplements several previous reports on the subject. The existence of spontaneous fluctuations sets a limit to the accuracy which can be obtained in the measurement of a physical quantity in a prescribed way, and a valuable account of the ways in which fluctuation theory has been applied to some of the simpler systems—suspended systems, electrical circuits, radiation detectors and feedback—of physical measurement is given in the report by C. W. McCombie. All experimental physicists should study this article, though they may find the theoretical details somewhat difficult to follow.

The remaining two reports in Vol. 16 differ from the rest. They are perhaps the best and the most appealing, one—on cosmology, by W. H. McCrea—because the author makes no pretence at writing a review of recent work, and the other—the new unstable

cosmic-ray particles by G. D. Rochester and C. O. Butler—because it deals with a new field of particle physics which will engage the attention of physicists for many years to come. In the former the main purpose is to describe the lines of thought and to discuss the aims and methods of cosmological theory and not to give a detailed comparison of theoretical and experimental results. The main current theories of cosmology and the model universes yielded by them are reviewed and critically examined, and the general physical features of the actual universe that may be inferred from its comparison with the various theoretical models are discussed. In the latter a detailed description is given of the properties of particles with masses between 400 and 2,200 electron masses. The authors were the discoverers of the neutral V-particles, and the evidence for these and related particles as shown in Wilson cloud chamber photographs of cosmic-ray showers is amply illustrated in a series of beautiful illustrations.

Volume 16 is excellently produced; but there is no index. The reports were again under the general supervision of the Papers Committee of the Physical Society under the chairmanship of Prof. S. Devons, and the executive editor of the publication is Dr. A. C. Stickland, the secretary-editor of the Society.

S. WHINTROUB

THE OXIDATION OF METALS

Oxidation of Metals and Alloys

By Dr. O. Kubaschewski and B. E. Hopkins. Pp. xv+239. (London: Butterworths Scientific Publications, Ltd.; New York: Academic Press, Inc., 1953.) 35s. net.

DURING the past fifteen or twenty years there has been a remarkable improvement in the capacity of metals and alloys to withstand high temperatures under service conditions. The jet engine and the gas turbine have been made possible by the skill of the metallurgist in providing alloys with improved resistance to both creep and oxidation. Generally, more prominence has been given to the improvements in mechanical properties, for these have been the more difficult to achieve and have been made only as the result of great and sustained effort, involving considerable man-power and expensive and impressive creep laboratories. Yet no improvement in mechanical properties would have been of value if it had not been accompanied by adequate resistance to oxidation. The oxidation of metals is therefore a very vital and topical subject for the technologist no less than for the fundamental scientist, who still finds tantalizing problems to be solved in this field. In making a critical survey of the work that has been done on the oxidation of metals the authors have undertaken a task that badly needed doing. The preface states that they have written from the point of view of the individual who is midway between the technologist and the theoretical scientist, but anyone interested in oxidation, from whatever angle, should find this book valuable.

The first chapter reviews the basic information on oxidation and includes useful tables of thermodynamic data, which may be used in deciding which oxide is likely to be formed on an alloy. It is stressed, early on, that most metals and alloys are unstable in air even at room temperature and that therefore the main interest is in the kinetics of oxidation—how rapidly is the oxide formed and what law is obeyed.

As an introduction to the later treatment of mechanism, this chapter includes brief but useful discussions of diffusion and electrical conductivity, and reviews the structures observed in films and scales as well as the effects of gas pressure and temperature on oxidation.

Many experimental methods have been used for the examination and measurement of oxidation; their advantages and limitations are here discussed and illustrated by typical applications. Descriptions of the techniques are brief and the reader is referred to other sources for operational details.

The parabolic oxidation-time law resulting from a diffusion-controlled process is obeyed by many metals within certain limits of temperature when the oxide film has become relatively thick. Accordingly, the authors give a fairly detailed exposition of Wagner's theory of parabolic oxidation and conclude that, within its limits, it may be of great help in the development of oxidation-resistant alloys.

Since it was intended that the emphasis of the monograph should be on fundamental principles and theories of oxidation rather than on oxidation-resistant alloys, it is appropriate that the experimental results should be reported in the final chapter in a somewhat condensed form. In spite of this, the treatment is comprehensive and co-ordinated and the reader will quickly find which original papers are of interest to him. Nearly 550 references are given and there are 84 figures.

Altogether this monograph makes a useful addition to the literature on the subject, and can be thoroughly recommended.

A. G. QUARRELL

ELECTRONS IN METALS

The Theory of Metals

By A. H. Wilson. Second edition. Pp. viii+346. (Cambridge: At the University Press, 1953.) 45s. net.

MANY of the basic principles of the electron theory of metals had been established in the early days of the development of quantum mechanics. By the time the first edition of this well-known book was published in 1936 it was possible to give a theoretical interpretation of many of the salient features of metallic behaviour. The developments since that time, making the appearance of a new edition especially welcome, have been fourfold. First, the mathematical theory has been further advanced. This advance has on the whole been beset with many difficulties and has been slow. Many outstanding problems remain only partially solved, particularly those connected with inter-electronic and electron-lattice interactions having applicability to such physical properties of metals as ferromagnetism and superconductivity. Secondly, there has been a marked improvement in the methods and techniques of numerical calculation. Thus, more accurate values of electronic energies have been obtained by the approximation methods described in the book, and, again, the fundamental transport equation governing conductivity phenomena has been solved with greater accuracy and reliability. Thirdly, it has been realized to an even greater extent that the theory is often so intricate that significant advances may only be possible if increased attention is paid to the analysis of the results of high-accuracy experiments, such results being now forthcoming in growing, though not yet sufficient, numbers. Finally, there has been a growing realization that the theory of

metals, far from being a purely academic field of study, has many applications in technology. An understanding of the theory of semiconductors, for example, to which the author has made such distinguished contributions, has led to the development of the transistor.

Solid-state physics is now a popular field of research, second in volume of significant output perhaps only to nuclear physics. An authoritative account of many aspects of this field, such as is provided in this book, will have a wide appeal. The fact that the theory of metals has come to cover such a wide range of diverse topics has made the inclusion in this book of only selected aspects almost inevitable. By far the greatest weight is given to the theory of conduction. The historical introduction deals with the development up to the Sommerfeld theory, and the formal theory of conduction, deducing the consequences of assuming the existence of a time of relaxation, is discussed in a later chapter. Here a theoretical discussion of one or other of the various 'effects' is usually followed by a survey of experimental data. The theory at this stage is formal, and the following chapter aims at removing this blemish by a detailed examination of the mechanism of conductivity and the physical significance of the time of relaxation. The mathematics is difficult, which is scarcely surprising, considering the complexity of the interaction of electrons with lattice vibrations and impurity atoms. The results of the analysis are not always in agreement with experiment, sometimes not even qualitatively so. Such discrepancies, as in the theory of thermal conduction, do not generally mean that the theory is 'wrong'. The physical situation being so involved, they are more likely to be the result of one or other of the simplifying approximations which make a development of the theory possible at all. Indeed, advances in this field are often consequent only on a re-examination of the validity of such approximations following the discovery that theory and experiment disagree. Other chapters on conduction phenomena include one on semiconductors and a final chapter on the application of the variation principle to the solution of the transport equation, a recent and fertile development in the theory.

Other topics in metal theory are discussed more briefly; nevertheless a surprising amount of detail not generally found in other books is included. Few accounts deal as adequately with the properties of the differential equation governing the motion of electrons in perfect crystals. An important chapter discusses adequately, though in only some forty pages, the various metallic structures as well as their Brillouin zone geometry, and also gives an account of the results of various energy band calculations, of the problems of metallic cohesion and of X-ray spectra in metals. Other chapters discuss the thermal and magnetic properties of metals, including an extensive account of the difficult theory of diamagnetism. A separate chapter treats ferromagnetism from the point of view of the collective electron theory.

In view of the general excellence of this book it is perhaps ungracious to voice one general, even intangible, criticism. The book appears to have too much of the appearance of a treatise on the subject, much as a standard work on some classical branch of mathematical physics. The very fact that there is still great scope for improvement in the theory, especially of its quantum mechanical aspects, is somehow veiled by the inclusion of so many detailed

mathematical deductions from premises based on some theoretical model used, perforce, in the absence of a sounder quantum mechanical description. The elegance of the mathematics should not give the reader a false sense of security, nor blind him as to the possible inadequacies of a particular model in giving an accurate description of what may be a very complex physical situation, of which no mathematical description in closed form may, in fact, be strictly possible.

E. P. WOHLFARTH

METALLURGY AND ATOMIC THEORY

Atomic Theory for Students of Metallurgy

By William Hume-Rothery. (Monographs and Report Series, No. 3.) Second (revised) edition. Pp. 331. (London: Institute of Metals, 1952.) 21s.

THE first edition of this book was published in 1946; it has since been reprinted twice, and now we welcome the appearance of a second edition in which several chapters have been amplified and brought up to date. It is an indication of the steady advance of the subject that a book of this kind, written primarily for honours degree students, should require such additions after so short a period; and the book itself is an indication of Dr. Hume-Rothery's determination to keep students of metallurgy abreast of developments in the fundamental aspects of their subject.

The recasting of this book has increased its size by forty-five pages, and meticulous care has been taken to present the latest data on each subject. For example, the old phase diagram of the copper-gallium system, used primarily for the purpose of illustrating general principles, has been replaced by a later and presumably more accurate one. Again, in the general introduction of Chapter 1 and in the well-known table of electronic configurations, we now find data referring to the transuranic elements. Some of the most interesting of the new material which this edition contains is to be found in Chapter 27 and concerns the behaviour of what are called defect structures. These are alloys in which the electron concentration appropriate to the phase is maintained, during changes of composition, by the creation of vacant lattice sites.

Chapter 29 deals with the difficult problem of the transition elements, and has been considerably extended in the second edition. This is, perhaps, unfortunate. In the introduction to the first edition we are told that "it has been thought better to concentrate mainly on the properties for which the theories have provided a reasonably straightforward explanation, and to avoid those whose interpretation is still in doubt". However, in this chapter, and to some extent in the succeeding one, we find theories which, to put it mildly, have not received general acceptance and which, in truth, are based on vague and unsatisfactory concepts. It is, however, a great merit of this book that none of the theories presented is expressed dogmatically, and little harm should result to the intelligent student if, in fact, some of the hypotheses prove to be wide of the mark. Moreover, there can be no doubt whatever that great benefit will be derived by all who study this excellent book as a whole, and who appreciate its true purpose.

H. JONES

KINEMATICS OF MECHANISMS

Kinematics of Mechanisms

By Dr. N. Rosenauer and Dr. A. H. Willis. Pp. 395. (Sydney: Associated General Publications Pty., Ltd., 1953.) £(A)4 10s.

PROF. ROSENAUER, who lectured on mechanism for many years in the University of Latvia, is now on the staff of the New South Wales University of Technology. The many contributions he has made in this field have been published in various learned journals of Continental Europe, where he enjoys a considerable reputation. This book is based upon his lectures and incorporates the fruits of much of his own research. It is a remarkable book in that it is the first publication on this topic which has appeared in the English language for a great many years. It is to be regretted, however, that the authors did not bear this fact in mind when writing it, for the British or American reader lacks the background possessed by his Continental counterpart, where the subject of kinematics has long been intensively studied. The approach adopted in Britain, in so far as the subject is treated at universities at all, is basically different: we do not lay much store by the extraordinarily thorough enumeration and examination of particular cases, so typical of German texts, to which this book is no exception. It is a large book and consequently costly; one feels convinced that if the material had been condensed to about one-third of its present bulk, and the price correspondingly reduced, the book would have gained not only in attractiveness but also in clarity, for fundamental methods and principles might thus have emerged from their present concealment.

One appreciates that it is a relatively novel departure for an Australian publisher to produce a scientific work of this magnitude, and since it is such a laudable venture one hesitates to criticize the production, which leaves something to be desired by British standards: the paper is not really suitable for printing fine line-blocks, of which there are nearly four hundred, and no attention has been paid to the size of lettering for the diagrams, in the light of their future photographic reduction for block-making. The result is that the letters vary in height on different diagrams between 1/16 in. and 3/16 in.

Although British and American work in this field is scarce enough, it is regrettable that the authors omit mention of even this little. Some of the work on kinematic chains published in Britain in 1950¹ is more general and more elegant than that given in the chapter devoted to this topic. There is no mention of 3-dimensional- (or space-) mechanisms, though an introduction to this topic would have been valuable, especially as it is in this field that there has been much American and some British activity in recent years.

The somewhat academic Euler-Savary and Bobillier methods, which take up much space, might well be omitted or mentioned merely in passing. On the other hand it is most useful to have, for the first time in book form, an account of Prof. Rosenauer's use of orthogonal velocity vectors on which are based many of the constructions in this book.

The final chapter is entitled "An Introduction to the Synthesis of Mechanisms". To design a mechanism to meet a given specification is, of course, the engineer's whole object in studying the kinematics of mechanisms. One or more points of the mechanisms are required to approximate as closely as possible to

a given motion, both in position and velocity, with limitations on the permitted accelerations of all parts of the linkage. There can be no question but that British mechanical design would benefit considerably if the underlying principles of kinematic syntheses were more clearly enunciated and more widely known. This chapter is a step in the right direction, but a far more fundamental examination and exposition of the properties of the four-bar chain are required to fill the present gap. Such matters as are treated in the chapter on straight-line motion would fall out of such an analysis as important special cases. Until such time as this is attempted, the designer will be content to rely upon atlases of curves, such as those recently produced at the Massachusetts Institute of Technology.

The authors and publishers are to be congratulated on their production of a most valuable book. It is sincerely to be hoped that this pioneering effort will inspire others to enter the field with works which will be of more direct value to practising engineers and which will make a greater appeal by adopting a fundamentally different approach, more in tune with the British engineer's background.

R. H. MACMILLAN

¹ Macmillan, R. H., "The Freedom of Linkages", *Mech. Gaz.*, 34, No. 307, 29 (1950).

THE ART AND SCIENCE OF DESIGN

The High-Speed Internal-Combustion Engine

By Sir Harry R. Ricardo. Fourth edition, rewritten and reset. Pp. ix+420. (London and Glasgow: Blackie and Son, Ltd., 1953.) 40s. net.

SOME years ago the reviewer was discussing tank design with one of its leading German exponents, who prefaced his comments on tank engines by remarking that German designers had found their inspiration in the translation of an early edition of the present book, and that he could not understand why so little attention had been paid to Ricardo's work in his own country.

Although this book is called the fourth edition, comparison with the third edition quickly shows that the impression thus given is entirely misleading; both books should be found on the shelves of every engineer, since not only does each contain much that is not to be found in the other, but also, taken together, they offer a fascinating insight into the workings and development of a powerful mind faced with the creative problems of design and manufacture.

Sir Harry Ricardo, in his presidential address¹ to the Institution of Mechanical Engineers, presented an autobiographical sketch of his development as an engineer which held his audience spellbound. Into this, his latest monograph, he has distilled such balanced wisdom on his own special field as every designer would wish to be able to do. Here are to be found the analysis of much research work, carried on over a period of almost fifty years, the experience and the conclusions he has drawn from it, the guesses and the surmises, the rational and the apparently irrational preferences; in short, the whole wealth of mind that is needed for great creative engineering. No engineer who has reflected on the problems facing himself can fail to be stimulated by the unique

presentation; yet at the same time the book is such as should be made compulsory general reading for every engineering undergraduate. It is, indeed, a cause for reflection that Ricardo started on the research work that was to shape his life's work when Bertram Hopkinson suggested to him that he should stop reading for the Mechanical Sciences Tripos at the end of his first year in order to assist in Hopkinson's work on knock, and thus left Cambridge labelled only with a pass degree.

While the chapter headings suggest that this is a comprehensive work on the high-speed internal combustion engine, its weakness as its strength is that it makes no pretence at being other than a monograph. There are neither footnotes nor references, nor is there more than occasional remark on the sources on which the author has drawn beyond his own laboratories; thus the reader unacquainted with the field might be led to accept as gospel certain matters which are open to dispute, and in matters where he might like to study more deeply, no clue is available as to where he should turn for more detailed information. This, however, is carping criticism, since an engineer whose writings display the full apparatus of scholarship is scarcely likely to have found time for the hard and laborious work involved in great mechanical design. D. B. WELBOURN

¹ *Proc. Inst. Mech. Eng.*, 152, No. 2, 143 (1945).

LOGIC FOR MATHEMATICIANS

Logic for Mathematicians

By Prof. J. Barkley Rosser. (International Series in Pure and Applied Mathematics.) Pp. xiv+530. (London: McGraw-Hill Publishing Co., 1953.) 85s.

THERE are many expert mathematicians who know little or nothing of symbolic logic. They have, of course, heard of Whitehead and Russell's "Principia Mathematica"; but cannot spare the time from their own researches to master its formidable difficulties. Now they have the chance to become acquainted with the subject much more easily. Prof. Rosser, by using Quine's technique, invented since the writing of "Principia Mathematica", claims to have condensed most of its three large volumes with its "out of date and extremely unwieldy symbolic machinery" into one book of moderate size.

The first chapter is addressed to those mathematicians who are not only completely ignorant of symbolic logic, but are also sceptical of its importance. This and the next four chapters seek to convert the unbeliever and to lead him very gently into the true faith, encouraging him by frequent references to the application of logical principles to ordinary mathematical theorems. But the reader who expects a mere confirmation of what he has always known will experience many shocks. "Some of these basic logical principles used by all (or almost all) mathematicians may actually not be valid. . . . Actually, some . . . have been subjected to severe criticism, notably certain uses of *reductio ad absurdum*". Moreover, "there is equally no guarantee that the symbolic logic is itself valid". However, from these principles—none known to be invalid, though some under suspicion—can be derived the existing body of mathematics, which is certainly useful in science and engineering.

The remaining ten chapters are more difficult reading; but even those who care little about logical technique will be interested by many references to ordinary mathematics. It is comforting, in these days of widespread references to electronic 'brains', to read that Alonzo Church's theorem proves that no machine can ever solve all problems solvable by a live mathematician. But mathematicians will not be pleased to be convicted of using the word function in two different senses, and thus producing confusion in a well-known treatise on the theory of functions. Much more disconcerting are the references to Gödel, Cantor, and the axiom of choice. According to a theorem of Gödel, "if a system of logic is adequate for even a reasonable facsimile of present-day mathematics, then there can be no adequate assurance that it is free of contradiction. . . . In fact, there is the awkward possibility that present-day mathematics is actually in serious error. . . ." "Cantor's theorem, to the effect that no class is similar to the class of all its sub-classes . . . is very useful in the classical theory of cardinal numbers. Unfortunately it seems to be false." But Prof. Rosser offers another theorem, which he believes to be true, to replace it.

There is a full discussion of the axiom of choice. Many mathematicians absolutely reject it. Some accept it readily, others with reluctance, doing so only because they believe that many valuable branches of mathematics are founded on it. Some who cannot accept the axiom in its usual form consider a weaker form, "the denumerable axiom of choice", far less objectionable, and on this a considerable amount of useful mathematics can be founded. ". . . to the best of our knowledge, one cannot prove the first fundamental theorem of Lebesgue without an appeal to the denumerable axiom of choice." "In topology, the axiom of choice is assumed from the very start. . . . Moreover, the question of how much topology could be done without the axiom of choice is apparently receiving no attention at all."

The last chapter sums up the principles established in this valuable and interesting book and applies them to an analysis of the merits and faults of some of the most esteemed mathematical treatises. It concludes with a bibliography and index. Nearly every chapter contains examples for solution. Every pure mathematician should read this book; unfortunately the very high price will mean that many will have to borrow it from a library, instead of buying a copy for themselves. H. T. H. PRAGGO

NUMERICAL ANALYSIS

Numerical Analysis

By Prof. D. R. Hartree. Pp. xiv+288. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 30s. net.

PROF. HARTREE'S book makes a considerable step forward in the literature of numerical analysis. The subject has a long history. It arose originally from the needs of navigators and astronomers and in the earlier days consisted largely of trigonometrical and geometrical applications. Later, calculations were aided by the invention and use of logarithms. Then elementary statistics was added, so that by the time the standard text-book of E. T. Whittaker and G. Robinson came to be written, an appropriate title appeared to be "The Calculus of

Observations", in spite of the fact that a large proportion of the book deals with finite differences and other tools of the makers and users of mathematical tables.

The Second World War greatly increased the demand for numerical work and stimulated the study of methods. In fact, numerical analysis is now recognized as a 'respectable' subject for mathematical study. Thus, although "The Calculus of Observations" has been a standard text-book for several decades, and remains a scholarly and useful book, it was written in the early days when computing was done with logarithms or with the earliest barrel-type hand machines. It is consequently lacking in numerical illustrations and examples adequate to present-day needs.

Other interesting and valuable books have also appeared from time to time, but they have either been too elementary to cover the most successful methods and formulae of modern numerical analysis, or they have been advanced and specialized mathematical text-books on the theory of finite differences and difference equations.

A further line of recent progress has been the rapid development of automatic electronic computers, with fantastic speeds of performance of elementary numerical operations. With their development, there has grown up a considerable body of users who have not had prior training in computing with desk machines, and who are unfamiliar with the many useful techniques that have been developed. There is thus a tendency to use simple, repetitive or iterative, but above all obvious, methods of computation on electronic machines and to argue that such methods are appropriate for such machines.

There is, then, a clear need for a book for practical computers, whether working with desk or automatic machines, which will show them the kind of process which may or should be tackled numerically, which will tell them the best processes to use for carrying out the numerical work, and which will provide examples, both worked and unworked, to help them to attain a better understanding of the processes described.

Prof. Hartree's book meets all these needs. The aim of the book is practical, so that no attempt is made to cover ground beyond practical needs, interesting though much of this may be. For each process, the formula or method advocated as best is given in detail. Some further good methods are also described in case the author's choice should not quite meet the user's needs. Very considerable emphasis is placed on the importance of *checking* and on methods for doing this.

The derivation and use of finite difference formulae is covered thoroughly, with almost exclusive emphasis on the use of *central* differences, followed by chapters on interpolation, integration and differentiation, and on the integration of ordinary and partial differential equations. Linear and non-linear algebraic equations, and matrices are covered fully, while a brief account is given of methods for summation of series, harmonic analysis, and smoothing (with adequate cautions on the often unappreciated dangers of this process).

A final chapter on the organization of calculations for an automatic machine gives an indication of possibilities that will be more and more widespread in the future.

This is a book that can be recommended for all computers of all ages—experienced or otherwise—and particularly as a text-book for students.

J. C. P. MILLER

SHORT REVIEWS

Whipsnade

By Philip Street. Pp. 128+31 plates. (London: University of London Press, 1953.) 12s. 6d. net.

THIS is really a dual-purpose book: it describes the birth and development of Whipsnade Park and is an 'everyman's' natural history of the inmates. In addition, it takes everyman behind the zoological scenes to make him understand the magnitude of the task of maintaining the Whipsnade estate and keeping the animals happy and healthy.

The history of Whipsnade makes most interesting reading and demonstrates the courage, energy and imagination of Sir Peter Chalmers Mitchell and Dr. Geoffrey Vevers.

It is depressing to read of the number of species which are either extinct or nearly extinct through the depredations of sportsmen and the demands of agriculture. There is a dramatic story of the rescue of the Père David deer by the tenth Duke of Bedford, who built up a flourishing herd from the eighteen known survivors of the species of which the thriving Whipsnade herd is an offshoot.

The natural-history section, well written and clear, leaves the reader speculating and anxious for further information; but as it is written for the layman it is rather misleading to say that most of the mammals in Australia are marsupials; except for some bats and the odd mouse the indigenous mammals of Australia were marsupials; but since man arrived placental mammals are gradually ousting the native fauna. The statement, too, that deer do not exist in Australasia is only partly true in that they have been introduced by man in recent times and the red deer is flourishing in New Zealand.

The omission of a chapter on the anthropoids seems a pity; but these are small blemishes on a book which tells of an exciting experiment, in language which is plain, undramatic and elegant and which should do much to send its readers to Whipsnade to see for themselves.

Journal of Researches into the Geology and Natural History of the Various Countries visited by H.M.S. Beagle

By Charles Darwin (1839). Facsimile reprint of the first edition. (Pallas, a Collection of Offset Reprints of Out-of-print and Classic Scientific Works, Vol. 2.) Pp. xiv+615+16 plates. (New York and London: Hafner Publishing Co., 1952.) 55s.

IT is now 127 years since a young geologist, aged twenty-seven, returned to England from a five-year voyage. At an age when most men are starting upon their careers, young Darwin had seen memorable service as naturalist in H.M.S. *Beagle*: his mind was full of information that was to be sifted, interpreted and re-interpreted until it became the basis of the "Origin of Species" more than twenty years later.

Despite all that is said to-day about Darwin and Darwinism there must be many who have not read the classic "Journal" in which the day-to-day discoveries were noted, and on every page of which the imprint of new experience is clearly recorded. One can still read the story for its intrinsic interest, with admiration for the tenacity, the physical toughness and the insatiable curiosity of the traveller.

Certainly the pleasure of reading is enhanced in this fine facsimile of the 1839 edition, which is clearly printed and has the original notes, illustrations and index. Some illustrations have been added from the earlier narratives of Captains King and FitzRoy, and the diagrammatic drawing of the *Beagle*, made many years later by Captain King, has also been included.

The closing words of the volume recommend travel as teaching "good humoured patience, freedom from selfishness, the habit of acting for himself, and of making the best of everything, or in other words contentment". Darwin also says "To hoist the British flag, seems to draw with it as certain consequences, wealth, prosperity and civilization". To these extracts one can only add: *O tempora. O mores.*

W. E. SWINTON

A Field Guide to the Birds of Britain and Europe

By Dr. Roger Peterson, Guy Mountfort and P. A. D. Hollom. Pp. xxxiv+318+64 plates. (London: William Collins, Sons and Co., Ltd., 1954.) 25s. net.

A GOOD handbook on European birds for use in the field has long been wanted. It is true that some thirty years ago Wardlaw Ramsay wrote a handbook on European and North African birds, but it had no coloured plates and the descriptions were more of birds in the hand than in the field.

In the present volume every bird is figured either in colour or black-and-white and, in addition, there are lines on the plates pointing to the principal different markings of any two birds which appear similar in life. Opposite the plates the chief characters of each species are clearly given, and as birds of prey are, as often as not, seen on the wing—they are shown in flight.

The introduction has valuable illustrated notes on how to identify birds, and where and when they are found, with a timely note of caution as regards rarities. The letterpress is short—a few lines on size and markings, a line or two on voice, and finally a short note on habitat and nests. At the foot of many of the pages are useful distribution maps.

The authors are to be congratulated on producing a veritable *multum in parvo* on European birds.

N. B. KINNEAR

Logic and Psychology

By Jean Piaget. Pp. xix+48. (Manchester: At the University Press, 1953.) 6s.

THIS small book is based on three lectures given in the University of Manchester in 1952. The brief historical survey in the opening chapter explains why there is little co-operation at the present time between logicians and psychologists. The second chapter deals with the four main stages, extending over the period from birth to maturity, in the psychological development of operations. Finally, the operational techniques of modern logic are used for discovering and constructing structures which can be put into correspondence with the operational structures of psychology, and the use of these logical structures in psychological interpretation is discussed.

The symbolic algebra used in the third chapter is more readily understood by the short survey, written by one of the translators, of the more important

concepts of the algebra of logic which Piaget has applied to the analysis of the intellectual activities of the child.

The book makes a further contribution to the study of the application of logical techniques to psychological facts, and especially to the thought structures found at different levels of intellectual development.

Man and Number

By Donald Smeltzer. Pp. viii+114. (London: Adam and Charles Black, Ltd., 1953.) 7s. 6d.

THE book gives an interesting account of the development of man's use of number and of the social and practical influences which have affected that development; it shows how early man acquired a sense of number and the gesture and spoken languages of number; it traces the evolution of the written language of number with early methods of recording numerical information and carrying out calculations to the wonderful inventions of modern calculation—the Arabic notation, decimal fractions and logarithms. The final pages of the book deal with inconsistencies and disadvantages in our present number system and how they might have been avoided by scientific planning. There is a useful bibliography but no index.

The appearance of such a book is a welcome addition to the small number of books on the history of mathematics of appeal to the general reader who is interested in human customs and their evolution, and to pupils in secondary schools. To the teacher of elementary mathematics the book will serve as an introduction to the more detailed works of Smith, Cajori and Rouse Ball, and as a source of material for inclusion in classroom lessons.

Earth Science

By Gustav L. Fletcher and Caleb Wroe Wolfe. Third edition. Pp. viii+556. (Boston, Mass.: D. C. Heath and Company; London: George G. Harrap and Co., Ltd., 1953.) 21s.

THIS book is primarily designed for teaching the background of physical geography and geology to students of, possibly, rather unequal attainments. Each chapter is conveniently paragraphed on the decimal system and followed by exercises. It is adequately illustrated by diagrams and photographs; examples are nearly all taken from the North American continent. The style of writing is simple and direct, with suitable typography; so from the students' point of view it is easy to read. Of the thirty-four chapters, twenty-one are devoted to geological subjects, four to astronomy, and seven to the atmosphere. These are followed by appendixes, a bibliography, and index.

Students of physical geology and geography must be presumed to have had a grounding in simple physics and chemistry; but the book includes some irrelevant, trivial and very elementary matter which makes it of uneven quality, and it contains several statements which are inaccurate or insufficient: for example, the assurance (p. 396) that "you are not likely to be struck by lightning if standing under a tree".

The list of books recommended for reading with each subject could well be extended, but deserves careful grading from elementary to highly advanced. The authorities cited are mainly American with a sprinkling of British, and there are some notable omissions from both sides. Much of the geological

material and principles was anticipated in that little old classic, W. W. Watts's "Geology for Beginners", which surely ought not to have escaped the notice of the authors.

"Earth Science" is a compendium of useful information presented in a form easy to assimilate and to memorize; but it attempts both the formality of a text-book and the naïveté of a children's encyclopedia, and merits a careful pruning.

D. W. BISHOPP

The Oxidation States of the Elements and their Potentials in Aqueous Solutions

By Prof. Wendell M. Latimer. (Prentice-Hall Chemistry Series.) Second edition. Pp. xvii+392. (New York: Prentice-Hall, Inc.; London: Constable and Co., Ltd., 1952.) 42s. net.

THE first edition was published in 1938 and had 352 pages. In it the author not only assembled the scattered mass of free-energy data, but he also expounded methods of combining these data for the determination of the thermodynamic properties of ions in solution and for the interpretation generally of chemical behaviour. The value of his work as a thorough survey of this important field was soon recognized. Prof. Latimer has now extended his tabulation so that for each element the heats of formation, free energies of formation and entropies have been given for all important compounds. Also, he has added potential diagrams for all elements having more than one oxidation state; he has treated reaction mechanism more deeply; and has inserted the chemistry of the actinide elements.

Of the four old appendixes, 2 and 3, summarizing free energies of formation and equilibrium constants respectively, have been incorporated in the text. A new appendix (3) discusses methods of making accurate estimations of entropy values; finally, a new appendix (4) contains a set of questions and problems for study. The book has already established itself as a standard work and the extension and revision have enhanced its usefulness.

G. FOWLES

Small-scale Inorganic Qualitative Analysis

By Dr. J. T. Stock and P. Heath. Pp. iv+96. (London: University Tutorial Press, Ltd., 1953.) 4s. 6d.

WRITTEN by experienced teachers and entirely devoted to practical work, this is a complete book of small-scale analysis for students taking examinations of the British first-year university level. The introductory section of four chapters on apparatus, materials and techniques is extraordinarily well done. The descriptions of essential pieces of apparatus, such as the test-pipette, the centrifuge, the micro-slide and the special hydrogen sulphide reservoir, are given with a clearness and directness that could come only from a first-hand knowledge of small-scale analysis and long experience of its teaching. Where circumstances may not permit of the acquisition of the recommended pattern of apparatus the authors often describe simple home-made substitutes. Chapters 5-18 describe a scheme for the analysis of simple mixtures of customary acidic and basic radicals using the detailed small-scale procedure. In the scheme the authors employ the excellent zirconium method for the removal of phosphate, make sparing use of organic compounds, and generally adhere to well-tried methods of separation and identification. A summary of the scheme

appears later in the book in the form of a series of tables. Semi-micro analysis has come to stay and older teachers, unacquainted with its techniques, could rapidly master this book and give instruction with confidence.

G. FOWLES

Fundamentals of Chemistry

By Prof. L. Jean Bogert. Seventh edition. Pp. xx+648. (Philadelphia and London: W. B. Saunders Company, 1953.) 22s. 6d.

THE "fundamentals" are not only established but are also applied to medicine and the related arts. Of the book's thirty-two chapters nineteen deal with general chemistry and seven with organic compounds. All the chapters have been revised and some entirely rewritten: Chapter 18, on radioactivity and atomic energy, is new to this edition. In simple language and with unusual clarity Prof. Bogert gives a good introductory account of the elements and their chief compounds and of fundamental physical principles. He omits all mention of industrial processes and concentrates on the chemistry concerned with the living cell. Items of the contents illustrate this emphasis: colloids in the living organs, function of proteins in the body, physiological importance of oxidation, etc. The last six chapters deal severally with: the vitamins; digestion and the digestive enzymes; transportation, blood and lymph; metabolism; endocrine glands and their hormones; elimination, urine, and faeces. The versatile author excels in these chapters, for he has the rare ability of correlating his knowledge of chemistry and physiology, of selecting what is important and of expounding its significance. The book should appeal to students of medicine, hygiene and dietetics. In addition the reviewer would recommend it for the nursing school and for domestic science where this is taken at sixth-form level.

G. FOWLES

Estimation of Organic Compounds

By Dr. F. Wild. Pp. viii+239. (Cambridge: At the University Press, 1953.) 25s. net.

THIS little book brings within two covers a collection of the various means of determining organic compounds through the characteristic groupings present; its scope is deliberately limited to general methods, so that the more specialized fields, for example, sugars, sulphonamides and amino-acids, are not considered.

The scheme adopted can be illustrated by the treatment accorded to olefinic linkages. Hydrogenation, both on the macro- and micro-scale, is described in detail, as are also methods for bromine, iodine and thiocyanogen numbers and the allied process using peracids; there are also a number of miscellaneous methods given in brief form. The inclusion of iodine numbers in a book of this kind is interesting, since it is usually necessary to refer to works on applied analysis of more specialized character for descriptions of such methods.

Other classes treated on similar lines are alcohols and phenols, mercaptans, aldehydes and ketones, amines, nitriles, nitro-, acetyl- and benzoyl-compounds and the lower alkyloxy- and alkylimino-compounds. A few others, for example, nitroso compounds and isocyanates, are discussed in less detail. In some of the classes, particular methods for some individual members are included, for example, methanol (but not ethanol), formaldehyde, acetone. The Karl Fischer reagent is introduced under carbonyl compounds.

Experience would soon reveal that the 60 per cent strength quoted (p. 36) for a toluene solution of maleic anhydride is incorrect; the spelling 'xylydene', which occurs more than once, is unusual. These are, however, minor blemishes on a work which, with its companion volume in the qualitative field, will give the organic chemist a sound and useful start.

B. A. ELLIS

A Short Course in Organic Chemistry

By Harold Hart and Robert D. Schuetz. Pp. ix+326. (Boston, Mass.: Houghton Mifflin Company, 1953.) 4.50 dollars.

THE format, for a book of this class, is uncommon; its dimensions in inches, $10\frac{1}{2} \times 6\frac{1}{2} \times \frac{7}{16}$, and its large clear type permit of the bold presentation of important notes. The illustrations are varied and striking; indeed, the line drawings, the many plates in half-tone, the pictures of electron clouds, and the numerous ball-and-peg molecular models, disclose the authors' confidence in visual aid. The course, framed for adult students who need a working knowledge of organic chemistry but whose main interest lies in such fields as those of medicine, dentistry and agriculture, follows no prescribed syllabus. The scope is roughly the requirements in organic chemistry of the British university first-year course, but includes also the simple chemistry of petroleum, plastics, rubber, textiles, dyes, and explosives, as well as of vitamins, hormones and antibiotics. The approach is not by the study of alcohol, or by the analysis of organic compounds—a section entirely omitted—but by the electronic theory and the explanation of simple reaction mechanisms. The judgment shown in the selection and arrangement of the material is to be commended. The main emphasis is on biological aspects and on everyday applications of recent discoveries. The treatment is clear and interesting, yet a topic requiring effort for its understanding, such as optical isomerism, is not avoided. In general, aliphatic and aromatic compounds are treated together. The simple applications of the electronic theory, the use made of the structure of molecules, and the up-to-date information should commend this book to teachers as well as to the class of students for whom it was written.

Notes on Qualitative Analysis

By H. J. H. Fenton. A new edition, by Dr. B. C. Saunders. Pp. vii+126. (Cambridge: At the University Press, 1953.) 15s. net.

THAT many years have passed since this book was revised is a testimony to the worth of Fenton's tables of analysis and to his selection of reagents. Dr. Saunders has put into this edition not only his own experience but also that of his colleagues at Cambridge. He has changed the tables but slightly, adding here and there an alternative separation, and he has inserted a well-chosen selection of modern reagents and procedures. Among these are Holness's effective way of bringing the arsenic group sulphides into solution and both the titanium and the zirconium methods for the removal of phosphate. Apart from this, with the purpose of extending the use of the book to the sixth form of schools, he has made considerable alterations. Gone are the fifty pages on the reactions of organic compounds and in place appears a section on microanalysis. Dr. Saunders has rewritten the notes on theory, he has removed from the analytical tables substances not found in Advanced Level (General Certificate) syllabuses, and

he has added a simple outline plan of the scheme of analysis. The last item is a good teaching aid for it helps a student not to lose his way. The revision has been well done and "Fenton" is now a useful and reliable book for use in schools. G. FOWLES

Five-Membered Heterocyclic Compounds with Nitrogen and Sulfur or Nitrogen, Sulfur and Oxygen (except Thiazole)

By L. L. Bambas. (The Chemistry of Heterocyclic Compounds, a Series of Monographs, Vol. 4.) Pp. xi+403. (New York and London: Interscience Publishers, Inc., 1952.) 14 dollars.

THE principal themes of this volume—the fourth of the present series of monographs—are provided by thiadiazoles and isothiazoles. The latter compounds are known only as condensed ring structures as in the benzisothiazoles, whereas the former comprise both monocyclic and condensed cyclic types. These two groups of azoles, together with their selenium analogues, occupy the whole text except for eight pages devoted to representatives of the little-known dithiazoles, dithiadiazoles, thiatrazoles and oxathiazoles. Rational subdivision of each of the main themes allows individual topics to be treated on historical lines, and the author has not hesitated to introduce a controversial note by adding occasionally his own interpretation or point of view. As in earlier volumes of the series the text is profusely illustrated by admirably clear structural formulae and is supplemented by tables of preparative methods and physical constants for individual compounds: an adequate index is provided. Although current interest in the subject-matter is comparatively slight, the book nevertheless affords an excellent survey of its field and contributes its full share towards the major work of reference of which it forms a part.

J. D. LONDON

L. Farkas Memorial Volume

Editors: Adalbert Farkas and Eugene P. Wigner. (Research Council of Israel: Special Publication No. 1.) Pp. ix+309. (Jerusalem: Universitas Booksellers, 1952.)

THIS volume contains papers by teachers, colleagues, pupils and friends of Ladislav Farkas, who lost his life in an air accident in 1948. A portrait of him and an appreciation by Sir Eric Rideal appear at the beginning of the volume. There are twenty-four papers by authorities on a variety of subjects, all of which are interesting and useful. Some deal with reaction kinetics, including fast reactions, others with catalysis, adsorption, and enzymes. Farkas was professor of physical chemistry in the Hebrew University of Jerusalem, and all those who recognized the high quality of his work and his great promise must regret that his career was so tragically closed. This volume will serve as a reminder of one who was esteemed by all who met him.

J. R. PARTINGTON

Radiation Chemistry

Discussions of the Faraday Society, No. 12. Pp. 319. (Aberdeen: Aberdeen University Press, Ltd., 1952.) 35s. net.

THE well-known excellence of the General Discussions of the Faraday Society makes it unnecessary to do more than direct attention to the fact that one on radiation chemistry is available. The papers are fairly short, but they give intelligible accounts of their subjects and the discussions are helpful in that they introduce new material or new

aspects of the topics with which they are concerned. What is now called radiation chemistry deals mostly with the effects of X- and γ -rays in inducing chemical reactions. Most of the work is concerned with liquids, both organic liquids and aqueous solutions. Since organisms all contain water or solutions, the subject has a biological aspect. In some cases radiation may bring about polymerization, in other cases it may create free radicals. The exact mechanism is still not always fully understood and differences of opinion exist. The Discussion provides a good and intelligible survey of the subject and will be useful to many classes of reader. J. R. PARTINGTON

Physical Chemistry for Colleges

A Course of Instruction based upon the Fundamental Laws of Chemistry. By Prof. E. B. Millard. (International Chemical Series.) Seventh Edition. Pp. ix+618. (London: McGraw-Hill Publishing Co., Ltd., 1953.) 51s.

PROF. E. B. MILLARD'S book is probably well known to most teachers of physical chemistry, and it is only necessary to say that the fact that it has reached a seventh edition since it was first published in 1921 is an indication of its excellence. The text has been largely rewritten and rearranged, new material being added when necessary. Problems on topics usually found difficult by students are included. References to original papers have been carefully selected so that students may be encouraged to read at least some of them; many are to American publications, but by no means all. A good feature of the text is the experimental approach; although actual experimental methods and descriptions of apparatus do not appear very prominently, all the fundamental laws are discussed on the basis of numerical results rather than in an abstract or formal way, and most teachers will agree that this is the best way of making their meaning clear to students. It is very likely that individual teachers will vary the order of presentation somewhat; the reviewer thinks the section on thermodynamics (Chapter 18) could well come much earlier in the book, and the electrochemistry is rather condensed. More space is given to equilibrium and phase rule and to kinetics. There is little doubt that this book will continue to be popular, and the care which the author has taken in the revision will be appreciated.

J. R. PARTINGTON

Starch and Its Derivatives

By J. A. Radley. Vol. 2. Third edition, revised. (Being Volume Twelve of a Series of Monographs on Applied Chemistry, under the Editorship of Dr. E. Howard Tripp.) Pp. xi+465+35 plates. (London: Chapman and Hall, Ltd., 1953.) 65s. net.

THE second volume of Radley's comprehensive treatise on starch and its derivatives deals mainly with industrial aspects, including the manufacture of starch, the production of derivatives and the applications of these materials in adhesives, paper, textiles and foodstuffs. A detailed discussion is given of the methods of analysis available for the assessment of starches and starch products.

The text of many sections is substantially the same as that of the second edition published in 1943, new information being given only in the form of additional references and brief notes. New chapters have been contributed on the manufacture of corn starch (R. W. Kerr), on the production of chemicals from starch by fermentation processes (L. M. Christensen

and L. A. Underkofler), on the role of starch in bread staling (C. W. Bice and W. P. Geddes) and on physical methods for the characterization of starches (C. C. Kesler and W. G. Bechtel). These two volumes bring together in convenient form a mass of carefully documented information concerning the fundamental chemistry and technology of starch and starch derivatives. Like the earlier editions, this one also will be of the greatest value to all concerned with the study or manufacture and use of these materials.

E. L. HIRST

Chemistry of Carbon Compounds

A Modern Comprehensive Treatise. Edited by Dr. E. H. Rodd. Vol. 2, Part A: Alicyclic Compounds. Pp. xciii+488. (Amsterdam and New York: Elsevier Publishing Co. Inc.; London: Cleaver-Hume Press, Ltd., 1953.) 84s.

THIS volume fully maintains the high standard set in Vol. 1 (*Nature*, 170, 508; 1952). It is, however, more uniform in style, being largely the work of one author, Prof. R. A. Raphael, who has produced an excellent account of the chemistry, including the stereochemistry, of the various alicyclic types from single rings to polynuclear, condensed and bridged-ring systems and spiro compounds. Two short sections, on pyrethrins and hydnooarpic acids, are contributed by Dr. L. Crombie. Carotenoids are dealt with fully in a chapter by Dr. R. H. Hunter, and Dr. R. G. R. Bacon contributes a summary of polymeric derivatives of olefinic compounds, mainly rubber and rubber-like compounds, which are included here since the terpenes are included in Vol. 2B.

Like the previous volumes, this provides an authoritative source of accurate, detailed and up-to-date information, and includes numerous references to the original literature and review articles.

C. BUCHANAN

Kinetics and Mechanism

A Study of Homogeneous Chemical Reactions. By Prof. Arthur A. Frost and Prof. Ralph G. Pearson. Pp. vii+343. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 48s. net.

THE authors state that there was need of a book giving an adequate account of the relations between kinetics and reaction mechanism, and they have attempted to fill this gap. There is no doubt that the result is satisfactory. It can serve as a text-book for advanced students, a guide to young lecturers, and a reference book which, since it contains bibliographies, will put the reader in touch with the literature. Although many of the examples are chosen from recent publications, the classical investigations, such as those of Harcourt and Esson, are by no means neglected, and it is clear that the authors have read and digested a wide field of literature, not confined to that published in the United States. There is an intelligible account of the transition-state theory, the rather difficult subject of complex reactions is dealt with systematically, and the recent investigations on the mechanism of organic reactions as elucidated by their kinetics are very well covered. Some parts, such as catalysis and chain reactions, are rather briefly considered, but there are other sources available for these. Since the mathematical parts are clearly set out, a student should not have much difficulty in following the text. This is a book which can be recommended.

J. R. PARTINGTON

Changements de phases

Comptes Rendus de la Deuxième Réunion Annuelle tenue en commun avec la Commission de Thermodynamique de l'Union Internationale de Physique, Paris, 2-7 Juin 1952. Pp. ix+487. (Paris: Société de Chimie Physique, 1952.) 3750 francs.

THIS volume contains no fewer than sixty-five papers on various aspects of its subject, and discussions on them. Some of the communications are short, and one consists of only sixteen lines. The subjects are arranged in eleven groups, namely, condensation, critical phenomena, phase equilibrium in solutions, solutions of polymers and colloids, co-operative phenomena in solids, polymorphism and rotation transitions, kinetics in solids, ferromagnetism and lambda-points, fusion, transitions in amorphous bodies, and transitions in surface phases. The papers are accompanied by short bibliographies. The collection will no doubt be very useful to those working in the field; but the treatment is, in general, too condensed to be easily understood by others, and it might have been better to have dealt with a more restricted field and to have had fewer papers. It would also have been useful to have included summarizing papers for each group, so that the general results of the work could be ascertained. The lack of agreement disclosed in the discussions is also confusing to those not actually working in this field. The discussion was probably of value to the participants; but the general reader may wish for a more homogeneous and critical survey of the important subject than is presented here.

J. R. PARTINGTON

Data for X-Ray Analysis

(Philips' Technical Library.) Vol. 1: Charts for Solution of Bragg's Equation (d versus θ and 2θ). By W. Parrish and B. W. Irwin. Pp. vii+100. Vol. 2: Tables for Computing the Lattice Constant of Cubic Crystals. By W. Parrish, M. G. Ekstein, and B. W. Irwin. Pp. vii+81. (Eindhoven: N.V. Philips Gloeilampenfabrieken; London: Cleaver-Hume Press, Ltd., 1953.) 15s. each.

VOL. 1 contains graphs of lattice spacing against Bragg angle, covering a range from about 85° down to low angles corresponding to spacings of 21 Å., for chromium, iron, cobalt and copper $K\alpha$ radiations; the high angle limit is 40.5° for molybdenum. Spacings may be read to 0.01 Å. at low angles and, due to a change in scale, to 0.001 Å. at high angles, the $K\alpha_1$ and $K\alpha_2$ curves being plotted separately beyond a Bragg angle of 21° . The charts are intended for rapid determinations of lattice spacings in routine powder analysis, and they are admirably suited for this purpose. A still more open scale for lattice spacing might, however, have been used with some advantage at the very high angles, where the slope of the curves is sometimes as little as one part in forty.

The bulk of Vol. 2 consists of tables of $\frac{\lambda\sqrt{h^2+k^2+l^2}}{2}$

for the $K\alpha_1$, $K\alpha_2$ and $K\beta_1$ radiations of copper, nickel, cobalt, iron and chromium. The tables will shorten considerably the labour of calculating cubic lattice parameters, and, as they are given to six decimal places, they are suitable for work requiring high accuracy. Tables of $\sin^2\theta$ and of the Nelson and

Riley function $\frac{1}{2}\left(\frac{\cos^2\theta}{\theta} + \frac{\cos^2\theta}{\sin\theta}\right)$ are useful additions to the volume. A table of lattice constants of cubic

substances, due to Frevel, may be somewhat misleading as it is by no means complete. For example, although the β -brass and related structures are listed, the complex γ -structures in alloys are omitted as also are the α - and β -manganese structures.

I. G. EDMUNDS

Crystal Structures

By Ralph W. G. Wyckoff. Vol. 3. Pp. xi+641. 14.50 dollars. Second Supplement. (Supplement to Chapter 13.) Pp. 148. 4.00 dollars. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1953.)

THE appearance of Vol. 3 of this work marks the end of the first stage of the task which Dr. Wyckoff has set himself—the presentation of the whole of the results of crystal-structure determination. The two previous volumes (see *Nature*, 169, 681; 1952) were concerned with inorganic and some organic structures; the present volume is confined to organic structures, and, with the addition of the earlier organic section (Chapter 13), provides a complete review of organic structures up to about the middle of 1952.

The loose-leaf form of publication makes the removal of chapters in this way quite possible, and also allows the introduction of supplements, one of which is published together with Vol. 3. This supplement brings up to date some of the information in Vol. 2, and two more Chapters, 11 and 12, remain to be included.

The results are clearly set out, with brief descriptions of the various structures, tables of atomic parameters, drawings, and references. The drawings are of two types—schematic ones, showing the heights of the atoms above a reference plane, and perspective ones, showing the packing of the atoms, which are represented as shaded spheres. These latter drawings are often very beautiful; but it is questionable whether the information they provide justifies the work of preparing them; the more complicated molecules look quite bewildering.

It is a pity that the price of the book is so high. In particular, the supplement, consisting of relatively few pages without any binding, is very costly.

The Measurement of Particle Size in Very Fine Powders

Four Lectures delivered at King's College, London. By Dr. H. E. Rose. Pp. 127. (London: Constable and Co., Ltd., 1953.) 9s. net.

THREE properties, which Dr. Rose terms primary characteristics, are of importance in many industrially significant dusts and powders; they are size frequency, specific surface and particle shape. In his lectures, Dr. Rose is concerned mainly with the determination of particle size and size frequency and subordinately with specific surface. He refers to most of the techniques available for particle-size determination in powders within the size range 1 to 60 microns and discusses simply, but adequately, the theoretical principles of the various techniques and their practical application and limitations. The photo-extinction method, in which Dr. Rose is particularly interested, receives, rather naturally, more detailed treatment than other methods. He refers, also, to some of his own research work.

The lectures are interestingly written; the illustrations are clear; the equations are easy to read; and the whole forms a satisfying small book which should prove valuable not only to those with experience in

this field but also to newcomers, especially in helping to solve the problem of selection of the best method of particle-size determination for a particular powder or dust.

STACY G. WARD

Physical Formulae

By Dr. T. S. E. Thomas. (Methuen's Monographs on Physical Subjects.) Pp. vii+118. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1953.) 8s. 6d. net.

DR. THOMAS'S little book contains many of the more important results in statistics and classical physics. The chief criticism is that it is out of place in a series intended to supply science students at university-level with a compact statement of the modern position in each subject; and that it would have been entirely in keeping with this intention if it had dealt equally generously with modern physics.

G. R. NOAKES

Mechanics

(Lectures on Theoretical Physics, Vol. 1.) By Arnold Sommerfeld. Translated from the fourth German edition by Martin O. Stern. Pp. xiv+289. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1952.) 6.50 dollars.

THE appearance of this English translation makes a valuable addition to the books now available to introduce students to mechanics as a live subject. The contents of this volume have already been discussed in a review of the German edition (*Nature*, 168, 887; 1951); but it is worth stressing again the value of this introduction as a counter-weight to the tendency, so widespread in the teaching, particularly in English schools, of regarding mechanics merely as a branch of mathematics. The lively and readable style of the book has not been lost in translation. The book covers the contents of a normal university course in mechanics. The numerous examples with aids to their solution are all designed to bring home important points of principle, and none of them is of the 'ladder leaning against a wall' type, which is more suited to traditional examination papers than to develop an understanding of the subject.

This book, like the others in the same series, will help to make available to the prospective theoretical physicist the insight and the experience of one of the most successful and inspiring teachers.

R. E. PHIBBS

Principles of Modern Acoustics

By Prof. George W. Swenson, Jr. Pp. vii+222. (New York: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1953.) 30s. net.

IN this book the subject of acoustics is considered as the study of inter-related electrical, mechanical and acoustical systems as applied to the production and reproduction of sound, and, as may be expected, great use is made of analogies, especially in the discussion on electroacoustics.

For a thorough study of the analysis and description of acoustical phenomena it is, as the author quite rightly recognizes, very necessary to approach the problem from the mathematical angle. This is what is done in this book, and for those students who can think, reason and understand in terms of mathematical equations and deductions it will be helpful, for the author starts from first principles and his exposition is clear. It is not the book, however, for those students who require a general description of acoustical phenomena and devices and who are

satisfied with simply expressed explanations without the backing of mathematical theory.

In view of the space at his disposal the author has wisely decided to confine himself to the general methods of analysis, illustrated by application to a few typical devices.

A list of standard treatises on acoustics, mechanics and electricity is given in the many footnotes, and these should be of great service to those students who wish to pursue the study of particular topics to a further stage. T. M. YARWOOD

Methods of Mathematical Physics

Vol. 1. By R. Courant and D. Hilbert. (First English edition translated and revised from the German Original.) Pp. xv+561. (New York: Interscience Publishers, Inc.; London: Interscience Publishers, Ltd., 1953.) 9.50 dollars.

ENGLISH translations of standard German books are always welcome, and in view of the current demand for mathematics in scientific and technical applications it is particularly pleasing to have this translation. The original text was reviewed at length in *Nature* (153, 633; 1944) by Prof. Milne-Thomson, and readers are referred to this for details concerning the present volume. For the translation, it is sufficient to say that there are numerous additions and modifications, the most extensive of which is an appendix (to Chapter 7) by Wilhelm Magnus. This concerns the transformation of spherical harmonics. A pleasing feature is that the bibliography has been brought up to date. The printing is excellent.

L. S. GODDARD

Electrostatique et Magnéto-statique

Par Émile Durand. Pp. xii+774. (Paris: Masson et Cie., 1953.) 6335 francs.

THIS work is an uneasy compromise between a text-book and a reference book. Students who like spoon-feeding will be delighted by the author's painstaking elaboration of the subject and discussion of many examples in which all calculations are given to the last detail. Experimental physicists and engineers will find in it a wealth of up-to-date information about the mathematical basis of the most varied applications of the electrostatic and magneto-static fields. But one should not look in it for a deeper treatment of the fundamentals of the subject.

Within these limitations this book will certainly be very useful and can be warmly recommended. It is, of course, difficult to be original in treating such a classical subject, and the author's exposition follows the traditional lines. Nevertheless there are a few happy innovations. The Giorgi system of units is consistently used and many tables of typical constants are given, probably for the first time, in these rational units. An interesting chapter describes in a very practical spirit the numerical methods of calculation of field distributions. The treatment of the magnetic properties of matter, and especially that of ferromagnetism (a domain to which the French school has made a brilliant contribution), is particularly well done.

Although the exposition is generally clear, the style is rather pedestrian and there is no sparkle in the book of that elegance which used to be characteristic of the French scientific tradition. It was a shock to discover that the author is so estranged from this tradition that he barbarously denotes the tartaric rendered famous by Pasteur as "sel de Rochelle". L. ROSENFELD

Radioactivity and Radioactive Substances

By Sir James Chadwick. Fourth edition. Pp. xv+120. (London: Sir Isaac Pitman and Sons, Ltd., 1953.) 12s. 6d. net.

THIS text-book has stood the test of time and in spite of the remarkable developments in the field of nuclear physics during the past fifteen years it still remains one of the best introductions to the fundamentals of the subject. It was first published in 1921 and has now reached the fourth edition. The arrangement of the material in the new edition is substantially the same as that in the original edition, but where necessary the subject-matter and data have been modified or supplemented to bring it up to date. In the chapter on measurements more modern methods and techniques have been introduced and a new chapter on nuclear structure, in which nuclear stability, artificial radioactivity and nuclear fission are discussed, has been added. These revisions and additions are by Prof. J. Rotblat, who it will be remembered worked for many years at Liverpool under Sir James Chadwick and who is thus well qualified to revise a book originally written by Sir James. S. WEINTROUB

Optics

The Technique of Definition. By Arthur Cox. Tenth edition. Pp. 376. (London and New York: The Focal Press, 1953.) 17s. 6d. net.

IF the popularity of a book can be judged by the number of editions published, then this book must indeed be very popular, for it now appears in its tenth edition, the first having been published in 1943.

The work is devoted entirely to what are undoubtedly the most precious and vital parts of any camera, namely, lenses, and the subject is treated very exhaustively and thoroughly, in a language which the ordinary photographer can understand without becoming involved in scientific formulae.

The full study of lenses is admittedly highly technical; but the treatment here is so skilfully done that the reader cannot fail to become intensely interested, and he soon finds himself able to understand how his lens works and why, what may be expected of it and what is the best type to use. The gap between the scientific approach of the designer and the practical man who uses the lens has been bridged, and the photographer can now have an added zest and intelligence for his work, based on a more intimate knowledge of his chief tool.

It is not only the photographer who can derive benefit from the book. There are also excellent articles on the defects of lenses, such as aberrations of various types, distortion, etc., which will be found useful to any student of optics whether interested in photography or not. T. M. YARWOOD

Advances In Applied Mechanics

Edited by Richard von Mises and Theodore von Kármán. Vol. 3. Pp. x+324. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1953.) 9 dollars.

THIS third volume carries on the admirable tradition already established. The present book is almost entirely devoted to problems of fluid dynamics except for a long, careful, interesting and important article by Dr. Geiringer giving a very comprehensive account of some recent results in the theory of an ideal plastic body. There is also a short

article by Albert I. Bellin on recent work on non-linear differential equations of the second order.

G. F. Carrier gives an account of some boundary layer problems in oceanography, in heat transfer and in electrical relaxation oscillations. Zeldastani describes recent work which extends and generalizes the classical researches of Riemann on one-dimensional isotropic fluid flow. The problem of diffusion through a field of homogeneous turbulence is studied by F. N. Frankiel. H. F. Ludloff deals with the aerodynamics of blasts and G. Guderley with the presence of shocks in mixed subsonic-supersonic flow patterns. A short and useful article by L. Rosenhead gives a critical summary of most of the theoretical and experimental papers which have been written about wakes for Reynolds numbers less than 2500.

There is no doubt that this series of reports has become indispensable to research workers in applied mechanics. Perhaps it is not out of place to take this opportunity of recording the gratitude which all readers must feel to one of the editors, Prof. Richard von Mises, who died a short time ago, and to whose scholarship and vision we owe so much.

G. TEMPLE

The Great Palomar Telescope

By Helen Wright. Pp. 176+15 plates. (London: Faber and Faber, Ltd., 1953.) 12s. 6d. net.

AS an astronomer's account of the 200-in. telescope, written for the general reader, Miss Helen Wright's book is very satisfying. The instrument and its observatory are described fully, with many photographs and line drawings. There is an introductory chapter on the evolution of the telescope and the spectroscope, and an outline of the progress which had been made with the aid of the Mount Wilson 100-in. reflector up to about 1936. It is a book one would recommend strongly for inclusion in, say, a school library; and it would certainly be appreciated by the young science student.

Miss Wright writes with a lively journalistic manner. Except during the hiatus of the war years, indeed, the progress of the telescope was news, often quite exciting news. The atmosphere of mounting public interest is recaptured here, for reporting was immediate and full. The technical problems that were faced are described clearly in less vivid terms. Dr. G. E. Hale, who lived to see the major difficulties surmounted but not the completion of the work, is the central character of the story. But the adventures of the telescope itself, starting with the financial crisis of 1929, beset by floods at the Corning Works during annealing, pursued during the last journey to the observatory by hazards of ice and blizzard, speak of the effort and determination contributed by all engaged in the work. The author's treatment of the human side of the enterprise adds greatly to one's enjoyment of the book.

G. R. NOAKES

Linear Algebra and Projective Geometry

By Reinhold Baer. (Pure and Applied Mathematics Series, Vol. 2.) Pp. viii+318. (New York: Academic Press, Inc.; London: Academic Books, Ltd., 1952.) 6.50 dollars.

TWENTIETH-CENTURY mathematics shows a change of trend away from the details of particular theorems towards abstraction and the analysis of structure. The object of the book under review is to prove the essential structural identity of projective geometry and linear algebra. The author

has gathered together much material difficult of access elsewhere and supplemented it by his own researches. To a geometer of the older type the result is by no means easy reading. He will find little or no opportunity to use his geometric intuition; but a constant need for a good grasp of the concepts of abstract algebra. He may imagine that the author's object is not so much to prove the equality of projective geometry and linear algebra as to reduce the former to a satellite of the latter. However, to those who accept the abstract point of view the book has many merits. It deals with the representation of projective geometries by linear manifolds, of projectivities by semi-linear transformations, of collineations by linear transformations, and of dualities by semi-bilinear forms. Thus the geometry with which the discussion starts is reconstructed within such apparently purely algebraic structures as the endomorphism ring of the underlying linear manifold or the full linear group. The book contains seven chapters, and concludes with an appendix on the theory of sets, a bibliography, and an index.

H. T. H. PIAGGIO

Pages choisies d'analyse générale

Par Maurice Fréchet. (Collection de logique mathématique, Série A, No. 3.) Pp. 214. (Paris: Libr. Gauthier-Villars; Louvain: E. Nauwelaerts, 1953.) 000 francs.

'GENERAL ANALYSIS' is usually associated with the name of the American Prof. E. H. Moore, whose researches began in 1906, but actually those of Prof. M. Fréchet began two years earlier. Both sought to generalize the classical theory of functions of real variables and Cantor's theory of sets, but Moore was influenced by algebra and integral equations, while Fréchet was influenced by geometry. For several years these two authors developed the subject on somewhat different lines; Moore pointed out that Fréchet's approach was more abstract and more general than his own. Prof. Fréchet intended to write a book on general analysis as a sequel to his book on abstract spaces, but his appointment as professor of the calculus of probabilities diverted his interests. Now, after many years, he has been persuaded to collect and republish the most important of his papers on general analysis, some of which, scattered among the periodicals of several countries, had become almost inaccessible. The papers have been arranged in logical (not chronological) order, sometimes shortened, and grouped into chapters, supplemented by references to later developments by other authors. This has produced something very much like the book for which his friends and pupils had waited so long. The first chapter gives a general outline of the subject, the second deals with functional spaces, and the third with functional analysis. The fourth chapter introduces abstract spaces; the fifth and last, general analysis.

H. T. H. PIAGGIO

Foundations of Algebraic Topology

By Samuel Eilenberg and Norman Steenrod. (Princeton Mathematical Series.) Pp. xv+328. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1952.) 48s. net.

THIS book presents, for the first time, an axiomatic treatment of the complete transition from topology to algebra. Chapter 1 gives the axioms for a homology theory, and a set of general theorems deducible from them. Chapter 2 deals with simplicial complexes and triangulable spaces. In Chapter 3, a

homology theory is assumed given on triangulable spaces; the classical algorithms for computing the homology groups of a complex are then derived from the axioms, and using these, the axioms are shown to be categorical for homology theories on triangulable spaces.

Chapter 4 presents the concepts of category and functor. Chapter 5 makes the step from chain complexes to homology groups. Chapter 6 gives the classical homology theory of simplicial complexes, while in Chapter 7 the singular homology theory is defined and shown to satisfy the axioms. In Chapter 8, direct and inverse systems of groups and their limit groups are considered, as an algebraic preliminary to the development of the Čech homology theory given in Chapter 9; additional properties of the latter are set out in Chapter 10, where it is seen that the addition of a single new axiom characterizes the Čech theory on compact spaces. Two additional homology theories are constructed which are extensions of the Čech theory on compact spaces.

Chapter 11 gives classical applications of homology theory, including the Brouwer fixed-point theorem, invariance of domain, and the fundamental theorem of algebra. The authors state that a second volume is in preparation. The book is excellently written from the axiomatic point of view. R. G. COOKE

Description of a Magnetic Drum Calculator

By the Staff of the Computation Laboratory. (Annals of the Computation Laboratory of Harvard University, Vol. 25.) Pp. xi+318. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1952.) 52s. net.

THE publication of complete design information about a large automatic computing machine is something of a problem, partly because of the speed at which the subject has developed in the past decade and partly because of the magnitude of the task. As a result all too few computers are as fully documented as those designed and built at the Harvard Computation Laboratory. Four Harvard machines are now in existence. Mark I, also known as the Automatic Sequence Controlled Calculator, was completed in 1944 and is still in use at the Laboratory. Mark II was completed in 1948 and has since been in operation at the U.S. Naval Proving Ground, Dahlgren, Virginia. Mark III, which forms the subject of this volume, was the first of the series to make use of electronic techniques; it began to operate on a production basis at Dahlgren in 1951. Since that time development has continued and a further machine, Mark IV, has been built and is now working at Harvard.

Much of the logical design of Mark III matches the distinctive pattern established by its two predecessors. The decimal scale is used, and numbers are stored quite separately from instructions. This was one of the earliest machines to employ magnetic drums for internal storage and to exploit the possibilities of magnetic tape as an input/output medium. The nine drums were carefully engineered and use a rather conservative pulse density. A certain amount of checking equipment is built into the machine, which uses a word length of sixteen decimal digits.

Most of this book is devoted to details of the logical design, engineering and circuits of the machine. These are very fully covered and well illustrated. A description of how problems are prepared and presented to the computer is also given, together with some simple examples. E. N. MURON

Typical Means

By Prof. K. Chandrasekharan and Prof. S. Minakshisundaram. (Tata Institute of Fundamental Research Monographs on Mathematics and Physics, 1.) (Published for the Tata Institute of Fundamental Research, Bombay.) Pp. xi+140. (London: Oxford University Press, 1952.) 35s. net.

OF the numerous methods devised for dealing with oscillatory series, one of the most important is by the use of M. Riesz's 'typical means'. The first systematic account of what Prof. G. H. Hardy described as 'his beautiful theory' appeared in Hardy and Riesz's Cambridge Tract "The General Theory of Dirichlet's Series" in 1915. Since that time the subject has developed considerably. The book under review gives a comprehensive account, including a good deal of material hitherto available only in research periodicals and even some still unpublished when the book appeared. The first and second chapters deal with the general theory, including theorems of consistency and Tauberian theorems. The third chapter applies this theory to Dirichlet's series. The fourth chapter applies it to Fourier series, starting with a theorem due to S. Bochner on multiple Fourier series and including several results due to Prof. Chandrasekharan himself. A valuable feature of the book is the supplementing of each chapter by extensive bibliographical notes.

H. T. H. PIAGGIO

Stochastic Processes

By Prof. J. L. Doob. (Wiley Publications in Statistics.) Pp. vii+654. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1953.) 80s. net.

THIS text is important for at least two reasons. It meets a long-felt need for a systematic account of a subject which has grown rapidly during the past 20-30 years; and it is an account in English of a subject which has developed largely outside the English-speaking world. Readers for whom the Russian language is a closed medium will find here accounts of contributions by Gnedenko, Khintchine, Kolmogorov, Krein and other Russian authors.

There is an introductory chapter on elementary definitions and theorems in probability theory, but, as Prof. Doob points out, "there has been no compromise... probability is simply a branch of measure theory... and no attempt has been made to sugar-coat this fact". This attitude, indeed, sets the flavour. The reader who is not a specialist in measure theory will find the going heavy in places, but he may be consoled by the fact that there is a supplement on measure theory. After three chapters dealing with stochastic processes in general there come two chapters on Markov processes. In the first of these there is a lucid account of finite-dimensional Markov chains with an application to card shuffling. In the second there are applications to diffusion equations, including the Fokker-Planck equation occurring in various physical problems. Next comes a long chapter on martingales with an application to games of chance. Later, there are chapters on stationary processes, and the book ends with a chapter on linear least-squares prediction.

It is perhaps worth emphasizing that the present work is mathematical rather than applied in character, in the sense that mathematical formulation and method take precedence over the details of applications. L. S. GODDARD

Sampling Methods for Censuses and Surveys

By Frank Yates. Second edition, revised and enlarged. Pp. xvi+401. (London: Charles Griffin and Co., Ltd., 1953.) 38s. net.

THIS book, first reviewed in *Nature* (166, 245; 1950), has an established place as an authoritative manual on the general subject of sampling. The author now has more to say, sometimes by way of commentary on or expansion of what was in the first edition, but mostly by way of new material and developments. He has chosen to leave the eight chapters of the first edition unaltered, except for the insertion of references to the added material, and to add two new chapters. Chapter 9 consists of a series of further notes on the critical analysis of survey data. Broadly, these deal with general questions such as contrasts between domains, or the relative precision of different methods of sampling, especially when domains of study cut across strata; but the opportunity is taken to supplement an earlier treatment of simple regression by describing briefly the multiple regression procedure, and by showing how this concept is to be interpreted in terms of caustic systems. Chapter 10 deals with a number of miscellaneous developments. Modern machines for use in computation and census work are referred to, but so briefly that legitimate curiosity is not satisfied; most of the remainder concerns varied methods of sampling, of which lattice sampling may be singled out as an ingenious way of incorporating the same sort of advantages into sampling that are gained by designing agricultural and other experiments on such patterns. The book is brought up to date by a description of the sampling method used for speeding up the reporting of the results of the 1951 Census.

The author is to be commended on his industry in coping with a very intricate subject in such painstaking detail. The result, however, is a book that is by no means a delight to read, for the style is heavy and, in places, obscure. A most complicated notation means that the reader must not allow his attention to wander. For his sake it is a pity that the author has at times forgotten the rigours of his own notation, for example, on p. 298 in quoting a formula in words in the text, while he might have avoided adding to the confusion by using the first two letters of the alphabet in different senses in the same formulae, as he does on pp. 318-19.

J. WISHART

Cambridge Elementary Statistical Tables

By D. V. Lindley and J. C. P. Miller. Pp. 36. (Cambridge: At the University Press, 1953.) 6s. net.

THE statistical material in this set of tables consists of the normal, t , χ^2 and variance ratio distributions, the r - s transformation, factors for converting range to standard deviation, and random numbers, occupying in all ten pages. The remaining twenty-two pages are taken up by tabulations of x^2 , $\sqrt{x}$, $1/x$, $1/\sqrt{x}$, $\log x$, $\text{antilog } x$, $\sin^{-1}\sqrt{x}$, $\sinh^{-1}\sqrt{x}$, $\log n!$ and a one-page table of proportional parts from 2-99 (surely unnecessary).

The printing, binding and layout reach that high standard which one would expect from collaboration between the authors and the Cambridge University Press, and the price is such that the tables should, as the authors hope, be useful for students in schools and universities, and for the research worker who requires a handy set of tables for the occasional normal, t , χ^2 or F test. But one could have wished

that the statistical material had been treated a little more generously to the exclusion of material adequately covered by ordinary four-figure mathematical tables. Fisher's original tables of t and χ^2 covered the whole range of P , and z has since been extended in a similar manner. The central values have their uses, both for the student and research worker. The table of percentage points of the normal distribution might well be fuller, and possibly that of the ordinates also, and one misses a table of significance levels of r , which gives a quick test of association between two variates. Random permutations also have a claim to inclusion. The preface is confused on the relation between one- and two-tail tests, and thus, perhaps, has led to a rather curious choice of significance levels. Finally, the reviewer, at least, is left wondering why the non-statistical functions are all presented together instead of separately on pairs of pages.

F. YATES

The First Fifty Years, 1903-1953

Edited by F. I. G. Rawlins. Pp. xv+86+11 plates. (London: The Faraday Society, 1953.) Cloth 10s. 6d.; Leather 21s.

THIS little book is not a set piece; it is more in the nature of a birthday book in which people have been good enough to write interesting things about the Society, now on the threshold of its fiftieth anniversary; in these words, the editor, Mr. F. I. G. Rawlins, describes the purpose of the volume under review.

The Faraday Society occupies a unique position in the chemical world; it has fostered the study of physical chemistry in all its branches, first, by providing, in its *Transactions*, a medium for the publication of physico-chemical research, and secondly, and perhaps this has been its most important, as it has certainly been its unique, contribution, by organizing the famous 'General Discussions'. These symposia on current topics have been characterized by timeliness, and few of them have not been followed by a real reorientation of thinking on the subject under discussion. In addition, these discussion meetings have been notable social occasions; the editor says that he and the other contributors to the present volume have been "trying to enjoy ourselves"—not a difficult task for regular attenders of the Society's discussions.

It is most fitting that the first article in the book is a chapter of personal reminiscences by Prof. F. G. Donnan, since he has probably done more than any other single man to guide the Society along the right paths during its first fifty fruitful years; the other thirteen chapters give the reader a valuable and interesting bird's-eye view of the development of physical chemistry between 1903 and 1953. Mr. Rawlins need have no doubt that this book does indeed "demonstrate that the Faraday Society is a living organism, continually emitting and receiving new knowledge on its way towards equifinality"; long may it remain so.

H. N. RYDON

The Art of Scientific Investigation

By Prof. W. I. B. Beveridge. Second Edition. Pp. xii+176+5 plates. (London: William Heinemann, Ltd., 1953.) 10s. 6d. net.

PROF. BEVERIDGE, in preparing the second edition of his book on the methods and results of scientific investigation, has made some minor revisions and partly re-written the chapter on reason. Essentially, however, the book remains as reviewed in our columns on March 3, 1951. A. S. PARKES

INSTRUCTIONAL FILM RESEARCH IN PENNSYLVANIA

ACCOUNTS of the early reports of the Pennsylvania Instructional Film Research Program have already been given in *Nature*^{1,2}, and it is the purpose of this article to review shortly some further Pennsylvania reports* now available in Great Britain. In every Pennsylvania experiment in which the learning results have been objectively assessed, people have learned from the films shown them³. Many of these further studies confirm that films can teach effectively, and though this, in fact, is usually discovered incidentally, it is sometimes borne out as the result of the main purpose of an experiment, as in Study 29, which deals with the instructional effect of the film "How to Operate the 16-mm. Sound Projector Set".

Learning from films may be factual learning or motor perceptual learning. A group of the new Studies, 25-27, by S. F. Harby, is concerned with the use of film-loops, daylight projected, for the teaching of athletic skills. The film-loop demonstrations were as effective as live instructor demonstrations, the addition of physical practice and coaching to the film-loop demonstrations being advantageous. A directed system of watching the film-loops and of practice was better than leaving the students with no outside guidance.

Mental practice, defined as the symbolic or covert practice of a perceptual-motor skill and described as resulting from trying to "imagine the feel of it", is—according to M. A. May⁴—an ingredient in any film-learning situation. Study 28 compares the effectiveness of mental and physical practice. There is a point beyond which mental practice does not help. Twenty periods of physical practice were significantly more effective than twenty periods of mental practice. Films extend the time learners can and will practise mentally.

A number of earlier findings of the Pennsylvania research are confirmed by the new studies: repeated showings of a film can result in a worth-while increase in learning (Studies 29 and 25-27); increased experience of films in training improves the ability of an audience to learn from films (Study 20, by A. W. Vander Meer); and note-taking during the showing of films interferes with learning (Study 21, by Ash and Carlton, and also independently reported⁵).

As in all learning situations, the student who is to learn from films must wish to learn and perceive relevance in what is put before him. A number of the new studies deal with the motivation of the student towards learning, with his participation and involvement, and Study 24 shows that anxiety—fear of the consequences of failing in a test of knowledge gained from a film—leads to increased learning. The advantages of a pre-film test of performance and of factual knowledge are shown by Studies 29 and 35, and of providing the correct answers to all test-questions—rather than merely informing a student that he is right or wrong—by Study 30. Study 33 shows that written titles making plain the 'organizational outline' of a film increase learning, particularly for the less intelligent.

A further comparison of black-and-white and colour films (Study 28) shows that colour makes a

contribution to retention of what is learnt rather than to learning itself, but this contribution does not seem to be large enough to justify the additional cost of coloured films. The single Study (32) so far carried out on stereoscopic films shows no advantage in stereoscopy.

Study 23, "Film Profiles", by Loran Twyford, in examining the value of subjective evidence, has some general psychological interest and is also of interest because it may lead to a change in the method of film investigations. The popularity of a radio programme has often been assessed by what is called 'a rating profile', a profile based on polygraph recordings of the responses of a sample audience, peaks in the profile representing sections of the programme to which a large number of the audience respond positively. Would the rating of an instructional film based on positive responses 'I am learning' and negative responses 'I am not learning' be a valid rating of learning? It was found in the Pennsylvania experiments that the subjectively based profile was, in fact, correlated highly with an 'objective test' profile, and in another film investigation, outside Pennsylvania, the subjective judgment of an audience has appeared similarly valid⁶.

Report 31, by the director of the Pennsylvania research, is largely a more positive statement of principles previously put forward as "trends of results". In general, the sixteen studies reviewed confirm and refine earlier results, although a first experiment on stereoscopic films has been made, and a fresh finding may lead to a change in the method of film investigations.

C. DENTIS PEGGE

¹ Pegge, C. D., *Nature*, 168, 775 (1951).

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³ Greenhill, L. P., and Carpenter, C. B., *Med. Biol. Illustration*, 3, 30 (1953).

⁴ May, M. A., *J. Educ. Psych.*, 37, 1 (1946).

⁵ Ash, P., and Carlton, B. J., *Brit. J. Educ. Psych.*, 33, Pt 2, 121 (1953).

⁶ Pegge, C. D., *Univ. Film. J.*, 1, 3 (1953).

⁷ Carpenter, C. B., *Prog. Rep. Penn. Film Res.* 11 (1950).

REDUCTION BY X- AND γ -RAYS OF SOME SUBSTANCES OF BIOLOGICAL INTEREST

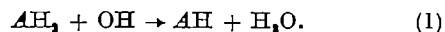
By DR GABRIEL STEIN*

and

DR A. J. SWALLOW†

Department of Radiotherapeutics, University of Cambridge

IT is usually considered that the main primary effect of ionizing radiations on aqueous solutions is to form hydrogen atoms and hydroxyl radicals¹. In the presence of a solute which can be oxidized in two steps, the hydroxyl radicals may react according to:



We wish to present a number of instances where a second solute is introduced in a concentration so small that the AH_2 protects it from hydroxyl radicals, and the effects observed on the second solute must be due to the action of AH radicals or hydrogen atoms, or both.

* Technical Reports S.D.C. 269-7-80 to S.D.C. 269-7-85 of The Instructional Film Research Program, The Pennsylvania State University, U.S.A.

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† I.O.I. Fellow, University of Cambridge.

Sources of radiation included cobalt-60 γ -rays, 220 kVp. X-rays filtered through 1 mm. aluminium, and unfiltered 200 and 190 kVp. X-rays. Dose-rates with γ -rays were 7-12 r./min. and with X-rays 500-3,000 r./min. Doses were of the order of 30,000 r. Temperatures were 20-40° C.

Methylene blue. In air-free solutions in the absence of other organic solutes, the decoloration of methylene blue (10^{-4} M) by X-rays is partly a reversible reduction and partly an irreversible oxidation². Addition of 0.5 M sodium benzoate results in an increased rate of decoloration, which is now entirely due to a reversible reduction. The addition of ethanol has a similar effect³.

In the presence of dissolved air, the reversible reduction cannot be demonstrated, and the irreversible oxidation can be prevented by sodium benzoate, which in this case is acting as a protective agent in the sense employed by Dale⁴.

Coenzyme 1. The irradiation with γ -rays of air-free aqueous solutions of coenzyme 1 (3×10^{-4} M, pH 7.8) in the presence of 0.5 M ethanol results in a yield of acetaldehyde three times greater than in the absence of coenzyme 1, and a substance with an absorption band at 340 m μ is formed⁵. This substance is also formed with X-rays at both pH 7.8 and 10.4, and tests with lactic dehydrogenase have shown that it is not identical with coenzyme 1 reduced enzymatically, and also it does not exhibit the characteristic whitish fluorescence of this compound. The irradiation product resembles the enzymatic product in that further irradiation changes the absorption curve in the same way, both substances slowly reduce methylene blue, and both absorption curves shift in the same way on addition of acid⁶. It may be that the irradiation product is identical with one of the substances made by reducing coenzyme 1 with sodium borohydride⁷. The irradiation product appears in the presence of 0.5 or 0.01 M β -hydroxybutyrate, *n*-propanol, *iso*-propanol or allyl alcohol. It is produced in 0.01 M but not 0.5 M solutions of lactate. No product appears at either concentration in solutions of benzoate, succinate, glucose or maleate⁸. None of the product appears in air-free solutions of coenzyme 1 alone or when hydrogen is present. In the presence of dissolved oxygen, the product could not be observed in the presence of any added substance.

Nicotinamide-methochloride. In order to obtain further information about the nature of the irradiation product of coenzyme 1, we have irradiated aqueous solutions of nicotinamide-methochloride with X-rays, and have found that in the presence of ethanol its radiation chemistry is similar to that of coenzyme 1⁹. The irradiation product (which absorbs at about 360 m μ in this case) has been extracted from the irradiated solution and found to have an absorption spectrum different from that of Karrer's N-methyl-*o*-dihydronicotinamide¹⁰; but it changes in the same way on addition of acid (Fig. 1). The product has a much weaker fluorescence than Karrer's N-methyl-*o*-dihydronicotinamide; it reduces silver nitrate instantaneously in the cold and decolorizes methylene blue at the same rate as Karrer's substance. The product does not appear when pure nicotinamide-methochloride solutions are irradiated in the presence of molecular hydrogen, or when pure solutions are irradiated in the absence of oxygen. In the presence of dissolved oxygen, the product does not appear whether ethanol is present or not.

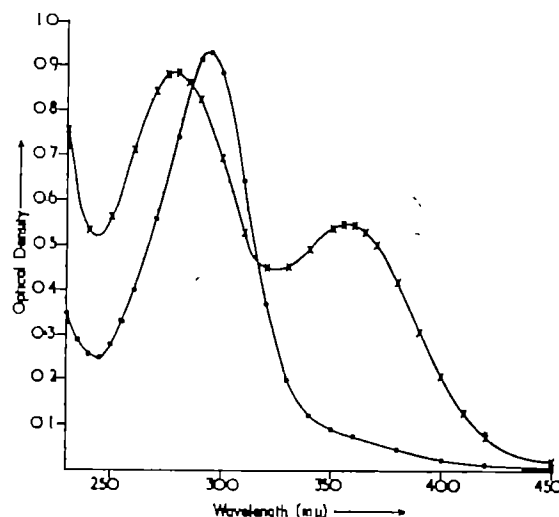


Fig. 1. Irradiation of nicotinamide-methochloride. Absorption curve of irradiation product (0.03 mgm./ml.). x—x, pH 11.0; ●—●, after acidification.

The structure of the irradiation product is not yet certain, but there are three positions in the pyridine ring at which reduction is possible¹¹. Karrer's N-methyl-*o*-dihydronicotinamide corresponds to one of the positions, and this is also the position at which reduction takes place when coenzyme 1 is reduced enzymatically. Karrer *et al.* have also prepared an N-methyl-dihydronicotinamide, which is stable to the addition of acid, and this corresponds to reduction at a second position¹². It seems possible that our product has been reduced at the third position.

Cytochrome c. The irradiation with X-rays of cytochrome c (10^{-3} M) in air-free solutions containing 0.5 M benzoate or succinate leads to a product which exhibits the typical absorption spectrum of reduced cytochrome c. The product can be reoxidized by ferriocyanide, and it reacts with the complete enzyme system of heart-muscle preparation, as does reduced cytochrome c which has been produced by, for example, hydrosulphite. If, however, methanol, ethanol, *n*-butanol or dissolved molecular hydrogen are used instead of benzoate or succinate, the irradiated solution contains a reduced product which can be oxidized with ferriocyanide; but both irradiated and reoxidized solutions have an absorption spectrum different from normal cytochrome c (Fig. 2)¹³. This latter spectrum is also obtained in a lower yield in air-free solutions containing cytochrome c alone.

The results given above show that organic additions do not all result in the same reactions on irradiation. This indicates that specific differences exist in the behaviour of the organic AH radicals, in broad agreement with the conclusions drawn by Mackinnon and Waters¹⁴.

The absence of any reduction in the presence of dissolved oxygen¹⁵ can be ascribed to the formation of peroxides by hydrogen atoms and AH radicals. It should be noted that AH radicals have been postulated as intermediates in some enzyme reactions^{11,12}, and the reactions we have described may be of interest in this connexion¹⁶.

In aerated solutions organic additions often exert a protective effect⁴. It is significant that in the present type of system organic additions can serve as potentiating agents; the effects of the radiation thus manifest themselves in good yield on components

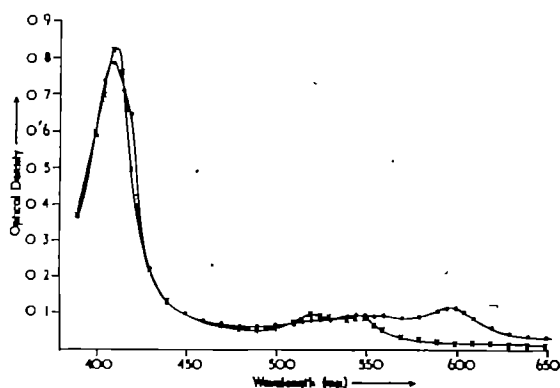


Fig. 2. Irradiation of cytochrome *c* in presence of ethanol. ●—●, absorption curve of irradiated solution after ferricyanide oxidation of reduced cytochrome *c*. ×—×, control cytochrome *c*.

present in very low concentration. Moreover, in the case of coenzyme 1 and under certain conditions with cytochrome *c*, the product is not identical with the enzymatic product, and essential components of enzyme systems have thus been inactivated. It may be significant that Holmes¹⁴ has found that in some irradiated biological systems the coenzyme 1 appeared to be the factor inactivated.

We wish to thank Dr. M. Dixon, Dr. E. Margoliash and Mr. R. P. Scutt for gifts of materials and valuable advice, and Prof. J. S. Mitchell for his interest. One of us (G.S.) is indebted to the Humanitarian Trust and the Friends of the Hebrew University for a grant. [Jan. 14.]

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A NEW CYTOCHROME IN LIVING ROOTS

By PROF. H. LUNDEGÅRDH

Institute of Plant Physiology, Uppsala 7

THE absorption spectrum of bundles of living roots of wheat and other cereals reveals the existence of a complete cytochrome system¹, composed of prosthetic groups similar to the cytochromes *a*, *c* and *b* of animal tissues and many micro-organisms². The system is responsible for 50–75 per cent of the total aerobic respiration, and it oxidizes succinate. The system has been studied in detail by means of a very sensitive new spectrophotometric

technique. Already the preliminary experiments with increasing levels of reduction have indicated the appearance of a new band at 570–575 mμ after prolonged anaerobiosis. It was tentatively concluded that this band belongs to an enzyme of lower oxidation-reduction potential state than cytochrome *b* and is possibly identical with succinic dehydrogenase. On continued investigation of the absorption spectrum, it has now been found that what was hitherto believed to be a joint *γ*-band of cytochromes *c* and *b* is in fact due to three cytochromes, and that one fraction of the joint band with its peak between *c*. 420 and 430 mμ belongs to a substance also characterized by the *α*-band at 571 mμ. The substance thus behaves as a true cytochrome and may be provisionally named cytochrome *dh*.

Time-course of Reduction of Cytochromes *b* and *dh*

Even if the joint *γ*-band of cytochromes *b* and *dh* occasionally shows a twin peak, no significant conclusions as to the existence of a new cytochrome can be drawn from the shape of the band only (cf. ref. 3,

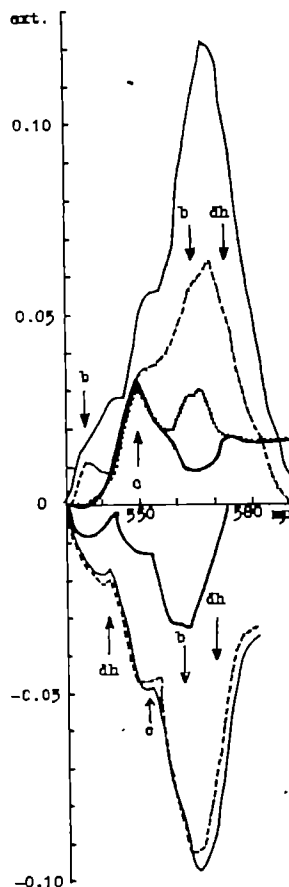


Fig. 1. Difference spectrum between roots under anaerobiosis and in aerated salt solution. The upper curves show the increasing reduction of the cytochrome system after stopping the flow of the solution. — after 3 min. (cytochrome *c* already completely reduced); after 7 min. (joint band of *b* and *dh* with its peak near 563 mμ); ——— after 12 min. (the peak of the joint band more toward 571 mμ); ——— after 45 min. (complete reduction; cytochrome *c* recognized as a hump at 550 mμ, joint band of *b* and *dh* with the latter dominating; *β*-band of *b* visible).

The lower curves show the increasing reoxidation after switching on the flow of aerated solution. — after 1 min. (negative bands of *c* and *b*); ——— after 2½ min. and ——— after 5 min. (oxidation complete, joint band of *b* and *dh* moved to the right).

p. 103). Conditions must be chosen under which the steady states of cytochrome *b* and of the new cytochrome behave differently. Two ways have been tested, namely, the time-course of increasing reduction or reoxidation, and the use of specific inhibitors.

By means of the new recording technique, it can be shown that in the course of increasing reduction, beginning from the predominant oxidation in an aerated dilute salt solution, the peak of the joint γ -band moves from c. 431 m μ to c. 437 m μ , whereas the α -bands to the right of cytochrome *c* begin with a peak at 563 m μ and then extend towards c. 571 m μ (Fig. 1).

From a large number of such series of spectrograms the following figures were computed:

Cytochrome <i>b</i>	431 and 563 m μ (red)
Cytochrome <i>dA</i>	424 and 571 m μ (red)

The shifting of the steady states of the single cytochromes can be conveniently recorded by starting from an aerated solution and simply stopping the flow through the recipient with the roots. A more rapid reduction is attained from starting in an oxygen-free solution of succinate. In this case the process is completed in a few minutes, because now only the quantity of oxygen present in the roots themselves has to be consumed. As shown in a previous communication⁴, the reduction of cytochrome *b* lags behind that of cytochrome *c* and the cytochrome oxidase. The reduction of cytochrome *dA* is still more retarded (cf. Fig. 1).

The steady states appearing when the supply of oxygen is reduced can be more closely studied if

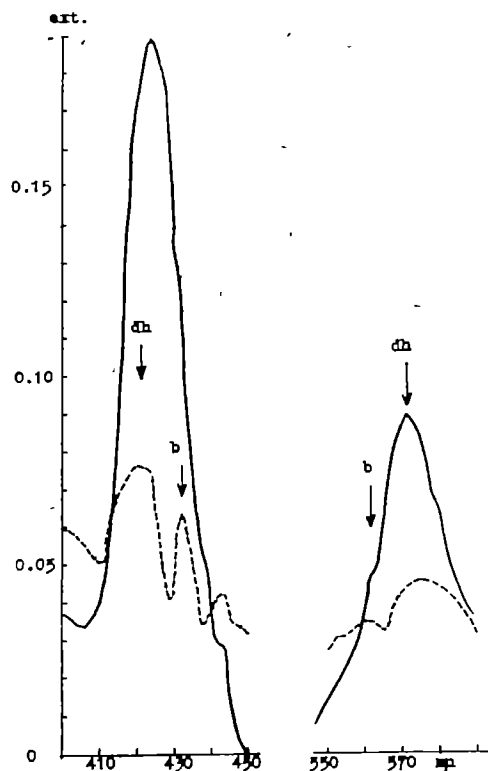


Fig. 2. ——— Difference spectrum of roots under complete anaerobiosis; cytochrome *dA* dominating. - - - - Difference spectrum of the same roots in a dilute salt solution containing 15.7 $\mu\text{mol. l}^{-1}$ oxygen (= c. 5 per cent of the normal tension). Separate bands of the cytochromes *b* and *dA* visible also in the γ -region (the extension of the *dA*-band to the left is caused by the *c* γ -band)

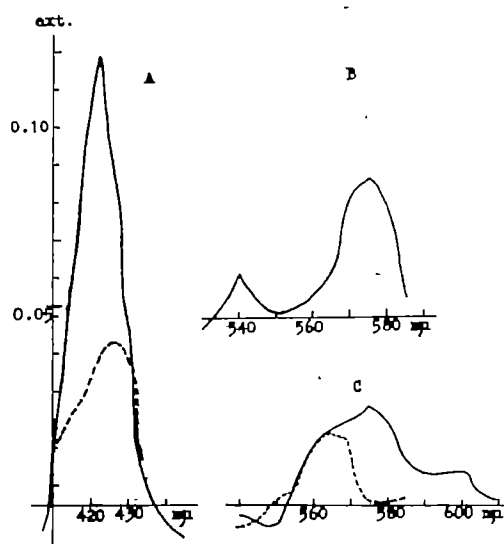


Fig. 3. Difference spectra of roots under complete anaerobiosis (—) and after treatment with 10 per cent urethane (see text). (A) The γ -band of cytochrome *b* in urethane (---) is moved to the right of the combined *b* and *dA* band under anaerobiosis (—). (C) The α -band of cytochrome *b* appears in urethane (---) to the left of the combined *b* and *dA* band under anaerobiosis (—). (B) Difference spectrum between the two curves in C, showing the reduced bands of cytochrome *dA*

the medium is exchanged for flowing solutions having a low constant oxygen pressure. Measurable reduction starts only if the oxygen pressure sinks below c. 10 per cent of the normal equilibrium between solution and air. The situation at a pressure of 5 per cent of the normal oxygen tension is illustrated by Fig. 2. These roots were exceptionally rich in cytochrome *dA*, the bands of which now can be clearly observed in addition to those of cytochrome *b*.

Differentiating Effect of Urethane and Fluoride

Urethane uncouples the electron transfer between cytochromes *b* and *c*, leaving the former in a reduced state, if the roots are treated with oxygen-free 10 per cent urethane and then transferred to aerated urethane (see ref. 3). Because the oxidation-reduction potential of cytochrome *b* is higher than that of cytochrome *dA*, the predominantly reduced *b* is balanced by a predominantly oxidized *dA*. As a consequence of that, the peak of the γ -band is moved from c. 424 m μ to c. 431 m μ and the corresponding peak³ at 571 m μ disappears. The spectrum of cytochrome *dA* can accordingly be calculated from the curves as the difference between anaerobiosis and treatment with urethane (Fig. 3). Besides the peaks at 424 and 571 m μ respectively, the reduced cytochrome *dA* shows a β -band at c. 540 m μ (Fig. 3).

The differentiating effect of fluoride is less distinct than that of urethane. 0.025–0.05 *M* sodium fluoride at pH 3.3–4.0 (cf. ref. 3) oxidizes cytochrome *b* almost completely and cytochrome *dA* to a considerable extent. Its effect is thus the reverse of that of urethane, because fluoride completely inhibits the reduction of cytochrome *b*, that is, the electron transfer from *dA*, and partly also inhibits the activity of *dA* itself. The net result is a shift of the joint reduced γ -bands to the left and of the α -group to the right. In the difference spectrum between roots in aerated water and roots in aerated solution of sodium-fluoride, the reduced peaks consequently

appear at 431 m μ ($\beta\gamma$ dominating), 535 m μ ($\beta\beta$), 550 m μ (α), and 563 m μ ($\beta\alpha$).

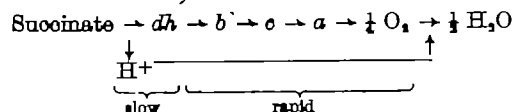
The experiments clearly show that fluoride primarily inhibits the transfer of electrons from $d\bar{h}$ to b , whereas cytochrome $d\bar{h}$ can still accept electrons, probably from succinic acid (see below).

Cytochrome $d\bar{h}$ and the Cytochrome System

Like cytochrome oxidase, cytochrome $d\bar{h}$ forms a compound with cyanide. The γ -band is in part moved from 424 to c. 435 m μ and the α -band at 571 m μ is moved to c. 585 m μ . This is the reason why the reduced bands of cytochrome c are 'cleaned' by cyanide (see ref. 3). Also, the bands of cytochrome b are affected by cyanide. The α -bands are weakened; but it is yet not decided if they also are displaced.

The sensitivity of cytochrome $d\bar{h}$ to cyanide is direct evidence against its linkage to the non-cyanide sensitive 'ground respiration'. This conclusion is supported by the observation that the bands are identically affected by cyanide aerobically or anaerobically. The obvious linkage to the succinoxidase system is, on the other hand, illustrated by the fact that reduced cytochrome $d\bar{h}$ is partially oxidized by fumarate (0.1 M at pH 3.3–4.0; see ref. 3) if the roots are held anaerobically, even in the presence of hydrogen cyanide. All the observed facts point in the direction of cytochrome $d\bar{h}$ probably being identical with succinic dehydrogenase.

In the approximate equilibrium between cytochromes b and $d\bar{h}$ attained in urethane (see above), b remains reduced to c. 90 per cent; but $d\bar{h}$ is oxidized to about the same degree. Assuming an oxidation-reduction potential state of 0.14–0.17 V. for cytochrome b (see ref. 3, p. 135), this corresponds to a potential of cytochrome $d\bar{h}$ slightly above zero (0.02–0.05 V.). In the steady states of the normally working cytochrome system, cytochrome $d\bar{h}$ will accordingly be highly oxidized and thus exert a maximum oxidizing effect on succinate. The extremely rapid reoxidation through the whole 'electron ladder' from $d\bar{h}$ to oxygen⁴ supports the conclusion that there is a very low resistance to electron transfer from $d\bar{h}$ to oxygen, the actual turnover at normal respiration being regulated by the slow oxidation of succinate. This process includes the formation of protons and electrons from the hydrogen atoms detached from the succinate. The complete cytochrome system of the roots thus may be pictured in the following way (arrow = electron transfer):



Relative Concentrations of the Haemin Enzymes In Roots and their Relation to the Quantities of Protohaemochrome

Assuming extinction coefficients of similar magnitude to those of cytochrome c (cf. ref. 3), the approximately equal height of the reduced bands of cytochromes $d\bar{h}$ and b points to an approximately equimolar concentration of these two enzymes in the wheat roots. The relation varies somewhat, however, and frequently shows a predominance of $d\bar{h}$ (cf. Fig. 2). The relation between cytochrome b and cytochrome c remains about the same as was earlier calculated, namely, c. 1.75. The fact that the revised

values of cytochrome b are not very far from the earlier calculated values depends upon the shape of the absorption bands in the γ -region. Two similar bands lying at a distance of 8 m μ join to form a single band. Its peak at c. 427 m μ is only about 20 per cent higher than that of the single bands at 424 and 431 m μ respectively.

Wheat roots also contain peroxidase (cf. ref. 5), the concentration of which can be measured from the height of the bands at 404 and 612 m μ of the fluoride compound (cf. ref. 6). The molar concentration varies but often exceeds that of cytochromes c and b , $d\bar{h}$. The band of the cyanide compound at 538 m μ ⁶ does not, however, appreciably disturb the appearance of the cytochrome c α -band at 550 m μ . Peroxidase is supposed to be reduced in dithionite only. If, however, the intracellular potential of roots during anaerobiosis promotes a reduction of peroxidase, it can be expected that the reduced band at 556 m μ will disturb the cytochrome c α -band at 550 m μ . This question is still unsettled; but reduction of peroxidase may be one of the reasons why in some roots in anaerobiosis the region 540–570 m μ is less transparent than would be expected from the presence of cytochromes only. Another possibility is the presence of a reserve of non-specific haemin which is partly reduced under anaerobical conditions.

The quantity of total haemochromes was determined after treatment of the roots with 10 per cent pyridine and dithionite. The appearance of a high, narrow band at 556 m μ and bands at 526–527 and 425–430 m μ indicates that the overwhelming part of the haemins are protohaemochromes. On fractional extraction with 10⁻³ M sulphuric acid, the haemochromes of cytochrome c appears at 550 m μ . If the concentration of protohaemochrome is calculated from the molar extinction at 556 m μ ($= 3.2 \times 10^4$) the value exceeds that of the enzymes b , $d\bar{h}$ and peroxidase by only c. 15 per cent, as shown by the following average figures from twenty separate experiments:

Cytochrome b	1.43	$\mu\text{mol. l. kgm.}^{-1}$	fresh weight
Cytochrome $d\bar{h}$	1.49	"	"
Peroxidase	1.16	"	"
Total enzymes			
haemochromes	4.08	"	"
Protohaemochrome			
determ.	4.80	"	"

The results show that cytochromes b and $d\bar{h}$ and peroxidase are related to protohaemochrome, but that some protohaemin may be present as a reserve or precursor of the haemin enzymes. There is no indication of haemoglobin-like haemin compounds in the roots (cf. ref. 7). Even if the non-specific haemin reserves are comparatively low in vigorously growing roots, they increase considerably in roots growing under less favourable conditions, a fact pointing to the existence of a pool of haemin more or less shifting over into active enzymes. Most of the non-cytochrome haemin is, however, present as peroxidase.

A detailed report of this work will appear in *Ark. Kemi (Roy. Swed. Acad. Sci.)*. [Dec. 27.

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³ Lundegårdh, H., *Ark. Kemi*, 5, 97 (1952).

⁴ Lundegårdh, H., *Nature*, 171, 521 (1953).

⁵ Lundegårdh, H., and Stenlid, G., *Ark. Bot. (Roy. Swed. Acad. Sci.)*, 31 A, No. 10 (1944).

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RADIATION-WIDTHS OF NUCLEAR ENERGY-LEVELS

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THE radiation-widths of levels of low excitation can, if sufficiently narrow ($\sim 10^{-6}$ eV.), be determined directly from the life-time of the state. The vast majority of levels, however, have much greater widths, which are often obtainable from properties of the nuclear reactions in which the levels are excited. The highly excited virtual states lying just above the energy corresponding to the neutron-binding energy have radiation-widths, for A greater than 100, of the order of 0.1 eV. These widths, typically constituting practically the total width of the level, can be measured by observation of the actual shapes of the neutron cross-section resonances that give rise to the excitation-levels. The cross-section resonances usually exhibit the simple one-level Breit-Wigner form, and the full width at half-maximum of the resonance represents the total width, Γ . The detailed shape of the resonance, in particular its peak height, allows the determination of Γ_γ , the radiation-width, by subtraction of the neutron-width, Γ_n , from Γ . The resolution available at the present time with slow-neutron velocity-selectors is sufficient to enable measurement of radiation-widths for many levels of heavy nuclei for excitation energies in the range 6–9 MeV. A survey of the radiation-widths already obtained from slow-neutron resonances reveals some interesting regularities and should be of value in its applications to theories of nuclear structure and in suggesting further measurements.

In Table 1, we present those radiation-widths that have been measured with 'reasonable' accuracy, of the order of 20 per cent. These values are based primarily on the work done in the past few years with pulsed neutron sources (the Columbia cyclotron¹ and the Harwell linear electron accelerator²), the crystal spectrometer at Brookhaven³, and the 'fast choppers' at Argonne⁴ and Brookhaven⁵. The present resolutions of the Harwell accelerator and the Argonne and Brookhaven choppers are about 0.1 μ sec. metre, or 0.09 eV. at a neutron energy of 10 eV. and 2.8 eV. at 100 eV. A resolution of this magnitude allows determination of Γ and $g\Gamma_n$ (with g the statistical weight factor) from the resonance shape up to energies of about 10 eV., and by 'area' methods to about 30 eV. The radiation-width is obtained⁶ from Γ and $g\Gamma_n$ in the general case by an assumption of $g = \frac{1}{2}$; for a zero-spin target nucleus g is known to be unity.

The first noteworthy fact concerning the radiation-widths is the small variation among levels in a single isotope and from isotope to isotope. This constancy is also shown in Fig. 1, which reveals a slight decrease of the radiation-width with increasing A . The excitation energies of the levels the widths of which are given in Fig. 1 range from 6 to 9 MeV., and represent levels in compound nuclei of odd Z -odd N (N , number of neutrons), odd Z -even N , even Z -odd N , and even Z -even N . None of these variables,

Table 1. RADIATION-WIDTHS OF SLOW NEUTRON RESONANCES

Target isotope	Spin (I)	Resonance energy (eV)	Γ_γ (mV.)	Ref.
¹⁶⁰ Rh	1/2	1.26	156 $\pm$ 5	a
¹⁶⁰ Ag	1/2	5.21	169 $\pm$ 10	b, c, d
¹¹⁸ Os	1/3	0.18	112 $\pm$ 5	e, f
¹¹⁸ In	9/2	14.7	80 $\pm$ 40	g
¹¹⁸ In	9/2	1.46	100 $\pm$ 20	h, i
		3.86	190 $\pm$ 30	j
		9.1	70 $\pm$ 30	k
		12.0	110 $\pm$ 40	l
¹⁶⁰ Te	1/2	2.33	104 $\pm$ 9	m
¹⁶⁰ Os	7/2	5.90	115 $\pm$ 20	n
		22.6	110 $\pm$ 40	o
		48	120 $\pm$ 60	p
¹⁴⁸ Gd	7/2	0.096	65 $\pm$ 2	q, r, s, t
¹⁴⁸ Hf	5/2	0.23	86 $\pm$ 2	u
		0.46	95 $\pm$ 2	v
		1.06	105 $\pm$ 10	w
¹⁴⁷ Gd	7/2	0.03	100 $\pm$ 30	x, y, z
¹⁴⁷ Gd		2.58	70 $\pm$ 10	aa
¹⁷⁸ Lu	>7	0.14	63 $\pm$ 5	ab
¹⁷⁷ Hf	<3/2	1.08	43 $\pm$ 10	ac
		2.36	78 $\pm$ 10	ad
		6.3	46 $\pm$ 15	ae
		12.9	100 $\pm$ 30	af
¹⁷⁸ Hf	0	7.8	30 $\pm$ 20	ag
¹⁸¹ Ta	7/2	4.29	100 $\pm$ 30	ah
¹⁸⁶ W	0	4.15	70 $\pm$ 20	ai
¹⁸⁶ Re	5/2	2.18	90 $\pm$ 20	aj
¹⁹⁷ Au	3/2	4.91	150 $\pm$ 20	ak
		61	190 $\pm$ 60	al
¹⁹⁸ Th	0	23.1, 23.8	35 $\pm$ 13*	am
		71	40 $\pm$ 40	an
²⁰⁰ U	0	6.7	23 $\pm$ 2	ao

* Γ_γ assumed to be the same for these two resonances

- a Saylor, V. L., *Phys. Rev.*, **81**, 63 (1953).
b Selove, W., *Phys. Rev.*, **84**, 859 (1951).
c Sheer, C., et al., Col. Univ. Prog. Rep., June 1952, OUD-116.
d Seidl, F. G. P., et al., *Phys. Rev.* (to be published, and private communication).
e Ramwater, L. J., et al., *Phys. Rev.*, **71**, 65 (1947).
f Brookhouse, B. N., *Can. J. Phys.*, **31**, 432 (1953).
g Carter, R. S. (private communication).
h McDaniel, B. D., *Phys. Rev.*, **70**, 832 (1946).
i Borst, L. B., *Phys. Rev.*, **90**, 859 (1953).
j Foote, H. L., jun., *Bull. Amer. Phys. Soc.*, **W43** (Jan. 1954).
k Landon, H. R., and Saylor, V. L., *Phys. Rev.* (in the press).
l Borst, L. B., et al., *Phys. Rev.*, **70**, 557 (1946).
m Sturm, W. J., *Phys. Rev.*, **71**, 757 (1947).
n Saylor, V. L. (private communication). Curves are given in Sup. 1 to ANOU-2040.
o McReynolds, A. W., and Anderson, H., *Phys. Rev.*, **93**, 195 (1954).
p Saylor, Landon and Foote, *Phys. Rev.* (in the press).
q Brill, T., and Lichtenberger, H. V., *Phys. Rev.*, **72**, 565 (1947).
r Bollinger, L. M., and Palmer, R. R., *Prog. Rep.*, May 1953, ANL-5060 (p. 15).
s Foote, Landon and Saylor, *Phys. Rev.*, **93**, 656 (1953).
t Bollinger, L. M., et al., *Phys. Rev.*, **92**, 1527 (1953).
u Hughes, Kato and Levin, *Phys. Rev.*, **93**, 1004 (1953), and private communication.
v Christensen, B. L., *Phys. Rev.*, **92**, 1500 (1953).
w Melkonian, Havens and Ramwater, *Phys. Rev.*, **92**, 703 (1953).
x Levin J. S. (private communication).

however, results in differences in radiation-width larger than the spread represented by the points of Fig. 1, which deviate on the average by only 20 per cent from the solid line. It is known from neutron resonance work not reported here that the spacings of the levels for the isotopes considered vary greatly, yet this difference in spacing apparently is not reflected in a change in radiation-width. An extreme example is furnished⁶ by hafnium-177 with a level-spacing of 8 eV. and hafnium-178 with 100 eV., both having similar radiation-widths.

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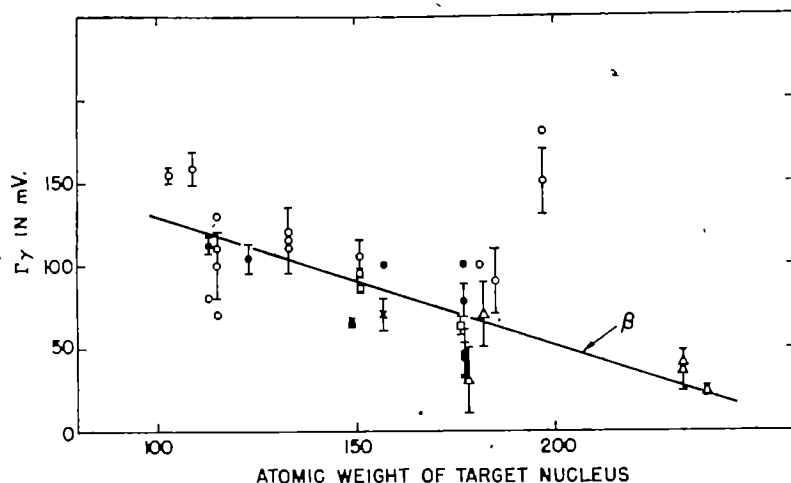


Fig. 1. Radiation-widths (Γ_γ) of slow-neutron resonance-levels plotted against atomic weight of the target nucleus. The symbols, $\circ$ odd Z -odd N , $\bullet$ even Z -even N , Δ even Z -odd N , $\square$ odd Z -even N , and $\times$ assignment unknown, refer to the compound nucleus. The errors are shown for the values of Γ_γ that have an accuracy of 20 mV. or better. Almost all the other points have large enough errors to agree with the straight line β .

As the levels studied represent a wide range of angular momenta, J , it is possible to investigate the dependence of Γ_γ on J , the spin of the compound nucleus. In Fig. 2, the measured widths are plotted against the spin of the target nucleus I , with $J = I \pm \frac{1}{2}$. In order to compare nuclei over a large range of A , the measured widths are multiplied by $100/\beta$, where β is the solid line of Fig. 1, in order to remove the slight dependence on A . It is obvious from Fig. 2 that there is little or no dependence of the radiation-width on J , the experimental points, with the exception of the anomalously high value for gold, being consistent with the horizontal line at 100 mV. This finding indicates that the transition probability of an energy-level (almost certainly electric dipole) is independent of J and that no $(2J + 1)$ factor should be included when comparing measured widths with theoretical transition probabilities.

The near-constancy of Γ_γ is of great value in the analysis⁴ of neutron resonances in the region of poor resolution, for example, 20–200 eV. Here the varia-

tion of Γ_γ from level to level is much greater than that of Γ_γ ; hence, in studying the former in the 20–200 eV. region it is safe to use values of Γ_γ obtained at lower energy to obtain Γ_γ from the measurements at poor resolution. The present results on Γ_γ also help to justify the use of a Γ_γ non-dependent on J in the work of Hughes, Garth and Levin⁵, in which level-spacings were obtained from measured capture cross-sections at an effective energy of 1 MeV. In particular, their finding that level-spacings for different J 's are about equal, which depends on the constancy of Γ_γ with J , seems justified.

It is a well-known fact that theoretical estimates of the electric dipole radiation-width of highly excited levels are much larger than experimental

results. For example, Blatt and Weisskopf⁶ calculate widths about 300-fold larger than those of Fig. 1, using the single-particle model. When the radiation-widths are combined with the results of capture γ -studies, which show what fraction of the total radiation-width Γ_γ corresponds to a given transition, it is possible to obtain the partial width for that particular transition. Thus Kinsey and Bartholomew⁷ find by this method that identifiable electric dipole transitions, the relative strengths of which vary greatly, have widths ranging from 0.002 to 0.6 of the single-particle theoretical⁸ value. (We here refer to the measured widths, suppressing the $(2J + 1)$ factor used by Kinsey in his comparison with theory, in line with the present observations.) Unfortunately, not many such cases are available because the measured total radiation-widths are usually for heavier nuclei than those used for capture- γ measurements. For much lighter nuclei⁸ the electric dipole widths of states at high excitation are about 0.1 of the values for single particles⁹.

Thus the radiation-widths so far measured seem to have a remarkable constancy, with the sole exception of a three-fold discrepancy for gold, for different level-spacings, different J 's, and different types of capture- γ decay schemes. It is possible that variations will be found in radiation-widths of isotopes not yet measured, and to this end, those exhibiting the largest differences in the characteristics just mentioned are being actively investigated.

It is a pleasure to acknowledge the help of C. E. Porter, R. C. Garth and Prof. M. H. L. Pryor in the present work, which was supported in part by the U.S. Atomic Energy Commission.

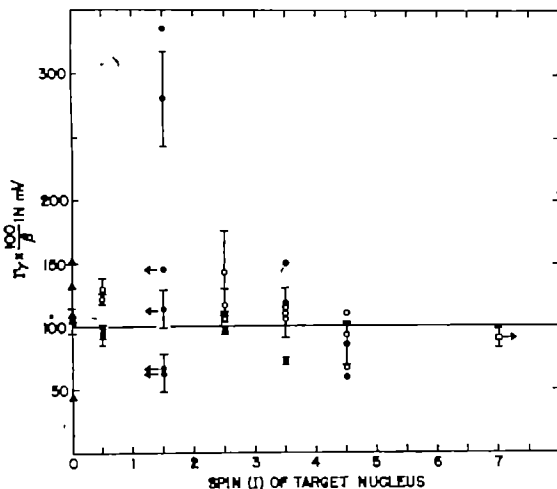


Fig. 2. Radiation-widths of slow-neutron resonance-levels plotted against spin of the target nucleus, with β the "best" straight line of Fig. 1. The symbols are explained in Fig. 1. Errors are shown if less than 25 per cent.

¹ Melkonian, Havens and Rainwater, *Phys. Rev.*, **82**, 702 (1953).

² Morrison, A. W., and Wihlin, B. B., *Nature*, **167**, 345 (1951).

³ Foote, Landon and Sellar, *Phys. Rev.*, **82**, 656 (1953).

⁴ Selove, W., *Rev. Sci. Instr.*, **23**, 350 (1952).

⁵ Seidl, F. G. P., et al., *Phys. Rev.* (in the press).

⁶ Hughes, Kato and Levin, *Phys. Rev.*, **88**, 1094 (1953).

⁷ Hughes, Garth and Levin, *Phys. Rev.*, **91**, 1423 (1953).

⁸ Blatt, J. M., and Weisskopf, V. F., "Theoretical Nuclear Physics", Chap. 13 (Wiley, 1952).

⁹ Kinsey, B. B., and Bartholomew, G. A., *Phys. Rev.* (in the press). We thank these authors for a preprint of their article.

¹⁰ Wilkinson, D. H., *Phil. Mag.*, **44**, 450 (1953); we have again removed a $(2J + 1)$, which must be estimated for some of the examples.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Lunar Radio Echoes and the Faraday Effect in the Ionosphere

SUCCESSFUL observations of the reflexion of radio waves from the moon have been made by workers in the United States and Australia. Both DeWitt and Stodola¹ and Kerr and Shain² found that the lunar echoes showed rapid fading (periods of seconds), for which the most likely cause appeared to be the libration of the moon. They also noted a different type of fading of much longer period for which no satisfactory explanation has been found, although Kerr and Shain obtained evidence that it might have an ionospheric origin. A radio echo equipment at the Jodrell Bank Experimental Station has recently been used in an investigation of the fading of lunar echoes; the results are in general agreement with this previous work as regards the origin of the short-period fading. The purpose of the present communication is to offer an interpretation of the long-period fading.

The equipment worked at a frequency of 120 Mc./sec. and the aerial system of 250 sq. m. aperture was arranged so that the moon could be observed for forty-five minutes at lunar transit. During thirty observing periods in the lunations of October and November 1953, 50,000 echoes were photographed and analysed. The night-time runs showed a steady r.m.s. signal amplitude (see Fig. 1a) while the day-time runs, particularly those within a few hours of sunrise, were characterized by severe fading (see Fig. 1b). The only runs which were exceptional were two night-time observations during which the fading occurred; on one of these nights there was also severe disturbance to trans-Atlantic short-wave communication, and on the other there was auroral activity. This general evidence therefore strongly suggests an ionospheric origin.

Kerr and Shain² showed that the movement of irregularities in the ionosphere might give rise to the fading. The speed of movement of these irregularities (300 m./sec. in the *F*-region, 50 m./sec. in the *E*-region) is, however, far too great to account for the fading periods of up to an hour observed in the present series of experiments. It is suggested that the long-period fading is due to the rotation of the plane of polarization of the radio waves as they traverse the ionosphere in the presence of the earth's magnetic field. Since the receiving aerial is plane-polarized, any slow rotation of the plane of polarization of the returned signals, as the electron content of the ionosphere varies, would give rise to changes in amplitude of the observed echoes. It can be shown from the Appleton-Hartree magneto-ionic theory that, for frequencies above 100 Mc./sec. and for restricted inclinations θ of the geomagnetic vector to the line of sight, the total polarization shift Ω for the double passage through the ionosphere is given approximately by

$$\Omega = \frac{7,490 H \cos \theta}{f} \int N dr \text{ complete rotations,} \quad (1)$$

where f is the transmitted frequency in c./s., H the geomagnetic field in e.m.u., $N(r)$ the electron number density per c.c. and dr cm. the element of path length

along the line of sight between the aerial and the moon where the electron density is N . Substitution in (1) indicates that the change in Ω necessary to give maximum to minimum fading would require a change in mean electron density of about 5×10^4 electrons/c.c. over a path length of 200 km. Such a change is observed in a period of 30–60 min. during early morning runs; its rate is consistent with the rate of change of electron density in the *F*-region associated with the transition from night-time to day-time conditions.

Experiments to confirm the effect have been carried out using the 250 sq. m. aperture horizontally polarized aerial for transmission and a separate aerial of 30 sq. m. aperture for reception; the latter was a paraboloid with a primary feed consisting of two dipole units mounted at right angles. The receiver was switched between the vertical and horizontal feeds at minute intervals. In five afternoon and evening observations during the lunation of March 1954 echoes were received in both planes of polarization, their relative r.m.s. amplitudes in the two planes varying differentially from day to day and also during the period of each run. For example, in a 45-min.

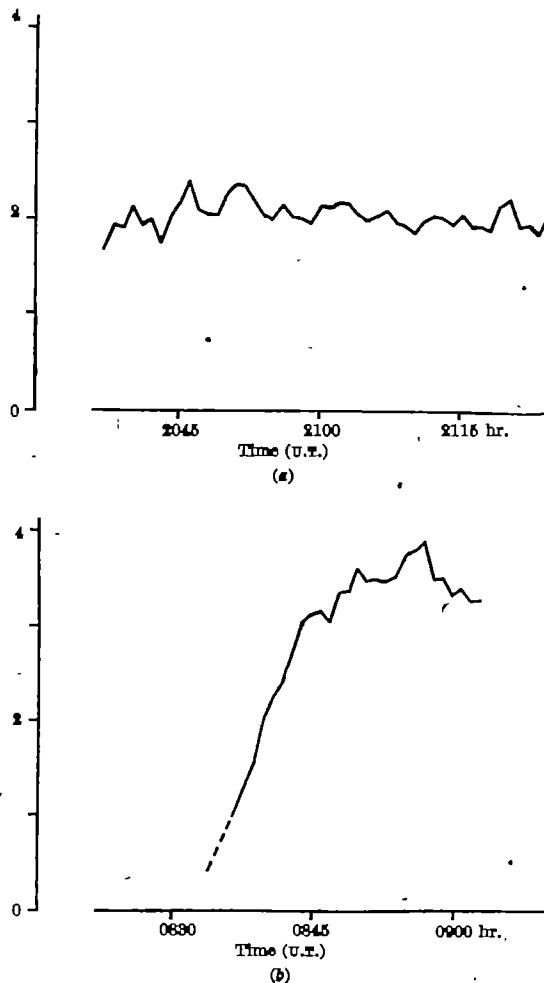


Fig. 1 a, Amplitude of lunar echoes during night-time observation on November 17, 1953. Lunar transit was at 2100 U.T.; b, amplitude record of lunar echoes during daytime observation on October 3, 1953, transit at 0840 U.T. Ordinates are amplitude signal/noise ratios (r.m.s. of 34 echoes in one-minute periods) corrected for the moon's position in the aerial beam

observing period commencing at 1650 U.T. on March 10, the amplitudes of the echoes in the two polarizations were equally divided at the start; shortly after transit at 1713 U.T., echoes were received only in the vertical plane; towards the end of the observing period echoes again became distinguishable in horizontal polarization. Such results confirm that the long-period fading is caused, at least in part, by a change of polarization in the received lunar echo.

In equation (1) $\int N \cdot dr$ is the total electron content of the ionosphere per sq. centimetre along the line of sight; the lunar echo technique thus affords a method for determining this quantity directly. The present experiments give only the rate of change of $\int N \cdot dr$. Measurements at two close-spaced frequencies would be required to determine the total rotation and hence the total electron content of the ionosphere.

We wish to thank Dr. I. C. Browne, Dr. T. R. Kaiser and Prof. A. C. B. Lovell, director of the Station, for their assistance in this work. One of us (W. A. S. M.) was the recipient of a maintenance grant from the Department of Scientific and Industrial Research during 1950-53.

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¹ DeWitt, J. H., and Stodola, B. K., *Proc. Inst. Rad. Eng.*, **37**, 229 (1949).

² Kerr, F. J., and Shain, O. A., *Proc. Inst. Rad. Eng.*, **39**, 230 (1951).

Galactic Radio Sources of Large Angular Diameter

THE survey of extra-terrestrial radiation, made at 1.89 m. with the 218-ft. paraboloid at Jodrell Bank, gave the position and intensity of 23 localized sources¹ between declinations N. 38° and N. 68°. The distribution of the intense sources showed a marked concentration close to the galactic plane, and it was concluded that they represented a class of rare objects in the Galaxy. A similar concentration has been found by Mills² from observations in the southern hemisphere. An attempt has now been made to measure the apparent angular width of these sources, and the present communication gives the preliminary results.

The measurements have been made at 1.89 m. using the 218-ft. paraboloid as an interferometer in conjunction with a small mobile aerial of 35 sq. m. aperture. The small aerial was placed at various distances along an east-west base-line from the fixed paraboloid, and in each position the amplitude of the interference pattern in the receiver output was recorded as the sources were in transit. The apparent angular size of each source was found from the change in the amplitude of the pattern with aerial spacing by using the well-known relation³ between the amplitude and the distribution of intensity across the source. The effects of systematic errors and long-period changes in the calibration of the equipment were minimized by daily observation of the transit of the intense source in Cassiopeia (No. 23) for which the intensity¹ and angular diameter is already known^{4,5}.

Table 1

Reference No. ¹	Galactic longitude (deg.)	Galactic latitude (deg.)	Intensity* at 1.89 m. (watt. m. ⁻² (c/s.) ⁻¹ × 10 ⁻²⁶)	Apparent angular width	Remarks
1	87.5	+2.1	170	—	Not measured
3	100.5	+2.1	80	>1.5° <3°	
7	111.8	-0.8	60	>1.5° <3°	
8	121.	-1.5	50	>1.5° <3°	
9	123.8	+3.8	80	1.4° ± 0.4°	Identified with nebula in Fig. 2
19	43.6	+4.9	5,700	2' 10" × 35" (ref. 6)	Identified as extra-galactic (ref. 10) Cygnus X
20	45.9	+0.8	300	1° or 5" (ref. 9)	
21	56.5	+4.1	200	1.5° ± 0.4°	
22	66.4	+2.9	50	—	Not measured
23	79.6	-2.0	9,350	5' × 4' (refs. 4, 5, 6)	Cassiopeia I

* The intensity given is the maximum intensity observed in a 2° beam. It has not been corrected for the finite size of the source.

The original survey¹ listed ten sources within ± 5° of the galactic plane, as shown in Table 1, all of which were classified as intense (> 50 × 10⁻²⁶ watt. m.⁻² (c/s.)⁻¹). The present observations have been restricted to five of these sources (Nos. 3, 7, 8, 9 and 21) and the measured values of their angular sizes are shown in Table 1. The angular sizes of sources 19, 20 and 23 have been quoted from previous observations⁴⁻⁶. Measurements could not be carried out on Nos. 1 and 22, since serious interference was experienced in their positions from the reception of nearby intense sources in side-lobes of the aerial system.

The variation in the amplitude of the interference pattern observed at different aerial spacings for source 9 is shown in Fig. 1. The results for source 21 were almost identical. In both cases the width of the equivalent strip source is about 1½ deg. Sources 3, 7 and 8 were found to be even greater in size and it was only possible to assign an approximate lower limit of about 1½-2 deg. to their equivalent widths, since the minimum spacing between the two aerials was restricted to about 20 λ by the size of the fixed paraboloid. An upper limit to the size of these three sources of about 3 deg. has been established by inspection of the records obtained in the original survey¹.

An examination of the sky in the position of source 9 has been made by Minkowski⁷ using plates

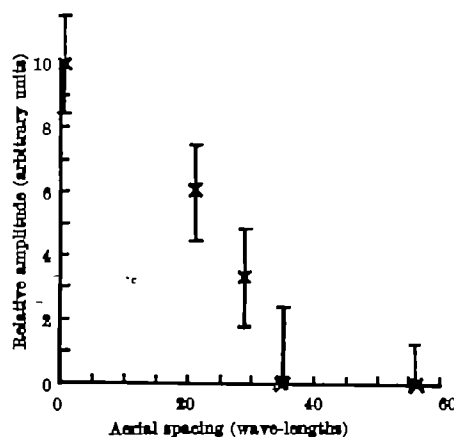


Fig. 1. The relative amplitude of the interference pattern observed from source 9. The value given for zero base-line is derived from the original survey (see ref. 1).

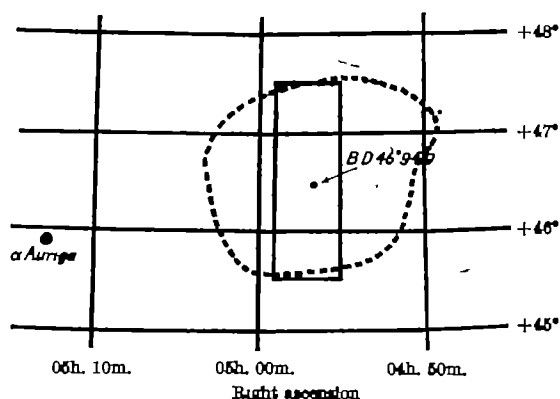


Fig. 2. A faint nebula in Auriga. The broken line shows the outline of the nebula. The position, and associated errors, of the radio source are given by the rectangle. The positions of α -Auriga and B.D. 46° 9' 49\"/>

taken during the National Geographic Survey with the 48-in. Schmidt telescope of the Mount Wilson and Palomar Observatories. He has found that in the approximate position of the source there is a faint nebula the outline of which is sketched in Fig. 2. The sketch has been made from an exposure taken in red light; only faint traces of the object can be seen in the blue. The nebula contains some faint filaments which are most prominent at the western edge. The co-ordinates of the radio source agree closely with the centre of the nebula, and the width of the equivalent source (1.4 ± 0.4 deg.) is comparable with the extension of the nebula in an east-west direction (~ 2 deg.). In view of this agreement, source 9 may be provisionally identified with the nebula.

In addition to the sources listed in Table 1 three other intense sources with large angular diameters have been reported close to the galactic plane in regions outside the field of view of the present equipment. Thus Mills⁸ has observed two intense sources with angular diameters greater than half a degree at $l = 229^\circ$, $b = 0^\circ$ and $l = 330^\circ$, $b = 4^\circ$. Bolton¹¹ has reported that the former of these two sources, in Puppis, has an angular diameter of about 1° . More recently, Baldwin and Dewhurst⁹ have observed a source in Gemini with an angular width of about one degree associated with the nebula I.C.443. Bolton¹¹ has also reported the presence of extended patches of radiation in the galactic plane, nearer to the galactic centre, which may result from the presence of several of these extended sources.

Thus, by combining the data in Table 1 with observations made in other parts of the sky, a total of at least nine intense sources with diameters of the order of a degree have been found close to the galactic plane; furthermore, at wave-lengths of about two or three metres, the apparent surface temperatures of these sources are all of the order of a few hundred degrees K. The similarity between these sources is striking and suggests that they represent a definite class of object in the Galaxy.

At the present time, only five objects in the Galaxy have been identified with radio sources. These are the Crab Nebula in Taurus¹², the nebulosities in Cassiopeia^{10,13}, Puppis¹¹ and Gemini⁹ (I.C.443) and the nebula in Auriga shown in Fig. 2. The radio sources associated with the Crab Nebula and with the nebula in Cassiopeia (source 23) appear superficially to be different in character from each

other and from the remaining three. They have angular diameters of a few minutes of arc and their apparent surface temperatures are of the order of thousands and millions of degrees respectively. The remaining three radio sources, which have been included among the nine sources already discussed, appear to be similar. Their associated nebulosities all show the presence of filaments but do not resemble each other exactly; nevertheless, the association of these three sources with nebulosities, together with their similarity to the other six unidentified sources of large diameter, indicate that the origin of this class of intense radio source is to be found in extended nebulosities of low photographic brightness.

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Proton Polarization at ~ 130 MeV.

RECENT theoretical investigations¹ of high-energy nucleon-nucleon scattering have involved the use of non-central forces in the description of the interactions between nucleons and consequently have predicted neutron and proton polarization. Experimental evidence for proton polarization was first obtained by Oxley *et al.*² at 240 MeV., and preliminary results from Harwell at 133 MeV., Chicago at 337 MeV. and Berkeley at 300 MeV. were reported at the Rochester nuclear physics conference³. Neutron polarization effects are much smaller than proton polarization effects under all the experimental conditions investigated to date³.

Nucleon polarization is detected in a double-scattering experiment. If the angle between the normals to the two scattering planes is φ and the angles of the first and second scatterings are θ_1 and θ_2 , then it may be shown that the asymmetry, ϵ , in the beam intensities $I(\varphi)$ after the second scattering is

$$\epsilon = \frac{I(0^\circ) - I(180^\circ)}{I(0^\circ) + I(180^\circ)} = P_1(\theta_1) P_2(\theta_2),$$

where $P(\theta)$ is the fractional polarization produced by a single scattering.

In the present experiment the internal (presumably unpolarized) proton beam of the Harwell cyclotron was scattered through 20° by a 10-MeV. thick copper or carbon target and was extracted from the machine by the aid of a magnetic deflector channel in an arrangement suggested by J. M. Cassels. The proton energy selected by this channel was 133 MeV., while the effective primary beam, taking into account multiple traversal effects, covered a range of 143–166 MeV. The polarized proton beam from the carbon first target had a flux of 3×10^8 protons/sec./cm.² at the second target, which was located behind a 6-ft. thick shielding wall and at a distance of 25 ft. from the first target. The beam from the copper target was 10^8 protons/sec./cm.². The protons scattered from the second target were counted in a triple-coincidence scintillation counter telescope with an azimuthal acceptance angle of 8° . When polyethylene was used as a hydrogen second target, the recoil protons were counted in coincidence with the scattered protons. The telescope could be moved in the plane of the scattering to vary θ_2 , and the framework on which it was mounted could be rotated about the axis of the beam to vary ϕ .

We shall use the notation (X, Y, θ_2) to denote that the first and second targets were of materials X and Y respectively and that the angle of the second scattering was θ_2 .

For conditions $(C, C, 20^\circ)$, $(C, C, 30^\circ)$ and $(C, U, 20^\circ)$, the asymmetry, ϵ , increased as the threshold energy, E_T , for proton detection by the counter telescope was raised (Fig. 1), while for $(C, H, 20^\circ)$ ϵ was, of course, independent of E_T and was equal to 0.14 ± 0.02 . For $(C, C, 45^\circ)$ and $(C, U, 45^\circ)$ ϵ was small (not statistically different from zero) for $E_T = 45$ and 112 MeV. The largest values of ϵ were found to be associated with a high-energy group of elastically or near-elastically scattered protons. In Fig. 2 are drawn the proton-energy spectra deduced from the

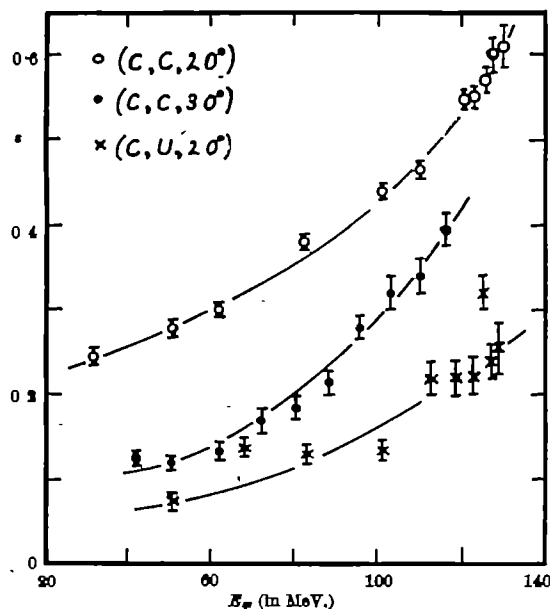


Fig. 1

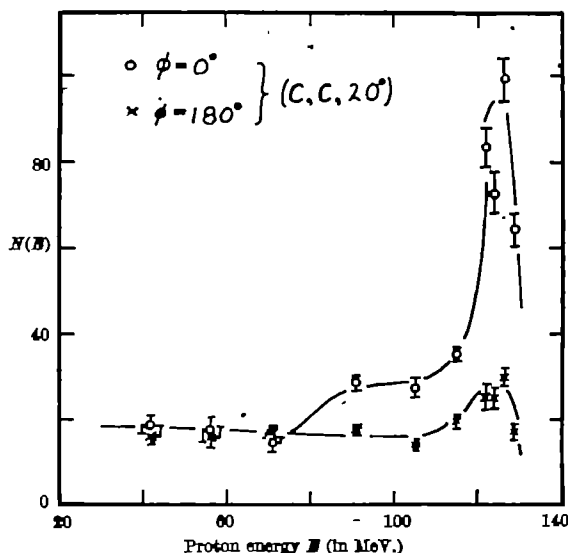


Fig. 2

absorption curves of $(C, C, 20^\circ)$, showing a very strong peak at the full energy corresponding to elastic scattering of the protons; the 'elastic' peak was much smaller for $(C, C, 30^\circ)$ (consistent with the first diffraction minimum near 30°), but it was well defined for $(C, U, 20^\circ)$. The asymmetry of 0.8 for $(C, C, 20^\circ)$ implies that P_1 and P_2 ('elastic') are both greater than 0.8. Now, making the assumption that there is no appreciable variation with energy between 133 MeV. and 143–166 MeV., P_1 must be less than P_2 , since the first scattering was not all elastic scattering; consequently, $0.6 < P_1 < 0.8$ and $0.8 < P_2$ ('elastic') < 1.0 . The asymmetry for inelastic scattering was much smaller than for elastic scattering. A diffuse group of protons was apparent for $(C, C, 20^\circ)$ with energies approximating to the free p - p scattering energy, and for this group $\epsilon = (0.27 \pm 0.05)$. No groups could be distinguished for $(C, C, 30^\circ)$ or $(C, U, 20^\circ)$, but in the appropriate energy-ranges ϵ was (0.15 ± 0.05) and (0.05 ± 0.03) . Below 70 MeV. the scattered protons showed no significant asymmetry.

In a similar beryllium-beryllium asymmetry measurement at Chicago at 337 MeV., ϵ was found to increase with E_T in such a manner that it was concluded that all the polarization effects were due to elastic scattering. At Berkeley the results of $(C, C, 15^\circ)$ measurements were interpreted as showing that both elastic and inelastic scattering produce asymmetry. There is therefore some uncertainty as to whether or not all the polarization is due to elastic scattering at about 300 MeV., whereas our results unambiguously show quite a pronounced asymmetry for the inelastic events.

The angular distribution (15° – 45° lab.) of the (C, H, θ_2) asymmetry is shown in the table. If the beam polarization, P_1 , is (0.7 ± 0.1) the free proton-proton polarization, $P(H)$, is (0.20 ± 0.05) at 20° . The value of $P(H)$ obtained by Oxley *et al.* at 200 MeV. was (0.22 ± 0.04) ($\theta_1 = 19^\circ$, $\theta_2 = 27^\circ$). Measurements at Berkeley of $(C, H, 20^\circ)$ and at Chicago of $(Be, H, 20^\circ)$ reported at Rochester² both gave $\epsilon = 0.2$, and from other measurements P_1 was at least 0.5, so that at 300 MeV. $0.2 < P(H) < 0.4$. There are therefore no large differences between the p - p polarizations at 130, 200 and 300 MeV. The

shape, of the angular distributions measured at Berkeley and Chicago were both substantially the same as the present measurements, but showed in addition that $P(H)$ was nearly constant from 20° to 5° . This is to be compared with the theoretically predicted $\sin\theta \cos\theta$ variation.

θ (lab.)	15°	$17\frac{1}{2}^\circ$	20°	25°
s	0.19 ± 0.03	0.19 ± 0.025	0.14 ± 0.03	0.11 ± 0.015
θ (lab.)	30°	35°	40°	45°
s	0.11 ± 0.03	0.07 ± 0.02	0.045 ± 0.03	-0.01 ± 0.015

The most direct interpretation of our measurements is that elastic scattering from carbon yields protons at 20° and 30° which are very highly polarized (> 80 per cent and > 60 per cent, respectively); these values are roughly four times the free p - p polarization at these angles. Similarly, elastic scattering from uranium at 20° gives a polarization approximately twice the free p - p polarization at that angle. Inelastic events also may yield polarizations higher than that in p - p scattering. The sign of the polarization effects has not been determined, but it is the same for nuclear and p - p polarizations.

This work on proton polarization effects is continuing and a fuller report will be issued later. We wish to thank Dr. T. C. Griffith for his collaboration in some of these experiments, and Dr. T. G. Pickavance and Mr. B. Rose for their continued encouragement and advice.

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Errors in Particle-size Determination from Settled Suspensions

THE particle-size distribution of finely divided materials is sometimes obtained by sizing settled suspensions under the microscope. This distribution is then assumed to represent that of particles orientated at random. In recent experiments on the extinction of light by silica dust suspended in liquid the cross-sectional area obtained microscopically seemed too large. Since the suspended particles were fairly uniform in size, it seemed improbable that the discrepancies arose from sizing errors, and more likely that the particles of extreme shape tended to settle flat on the slide.

In order to obtain samples which had not been orientated in this way, the particles were suspended in carefully filtered agar solution, and the suspension for sizing poured on to a microscope slide under conditions such that it set within a few seconds. In this way the orientation of the suspended particles was 'frozen in'. Hydrodynamic effects may orientate the particles in the agar before it sets, but they are unlikely to give rise to the same errors in sizing as does the orientation of the settled suspension.

The particles were then sized by microscope, using a Patterson-Cawood graticule, and classified

Table 1

Size range, microns	Mean area per particle (microns ²) and number sized (in brackets)		Significance level, difference between distributions: χ^2 test	
	Settled	Suspended in agar		
8-30	350 (960)	322 (373)	$P < 0.1$	5 D.F.
4-20	115.7 (663)	96.7 (452)	$P < 0.001$	5 D.F.
2.4-7.5	29.0 (400)	23.0 (343)	$P < 0.001$	4 D.F.
1.2-4	4.88 (390)	3.67 (153)	$P < 0.02$	6 D.F.

according to their projected areas. The technique employed was that used in the sizing of settled particles, except that the microscope was racked up and down to focus through the depth of the agar film. The size distributions obtained by the two methods were compared by means of the χ^2 test. Some of the original seven or eight size-groups had to be combined owing to the small numbers of particles in the larger groups.

Four different suspensions were studied (see Table 1). In each case the upper size-limit quoted embraced more than 90 per cent of the particles sized; most particles lay within considerably narrower ranges. There seems little doubt that the distributions are different, and can give rise to considerable differences in mean area per particle. The mean areas are, however, subject to considerable statistical errors owing to the small numbers of particles sized.

It is possible that similar differences in distribution might be obtained from apparently identical preparations. Three pairs of such identical preparations were therefore compared by the same technique; but no significant differences were found. The differences between settled and 'frozen-in' suspensions appear, therefore, to be real. The cross-sectional areas obtained by the latter method gave good agreement with those indicated by the light-extinction.

For particles smaller than about 1 micron diameter, the method becomes very difficult to use. Objectives of high magnification, short focus and small depth of focus must be used, and the volume in focus at any one time is small. Moreover, Brownian movement becomes more important and orientation seems less likely to persist.

I am grateful to Mr. M. J. Robbins, of the Department of Bacteriology, London School of Hygiene and Tropical Medicine, for preparing artefact-free agar solution.

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Variation of Hardness of Metals with Grain Size

In the past, several sets of measurements have been made of the variation of Brinell hardness number with grain size, notably on α -brass¹, copper and bronze², and 'Armco' iron³. The consistent increase of hardness with grain size was interpreted by these workers^{1,2} as being dependent on the amount of grain boundary area; that is, a plot of the hardness number against $1/d$, where d is the grain diameter, gave a straight line. However, I have found that a

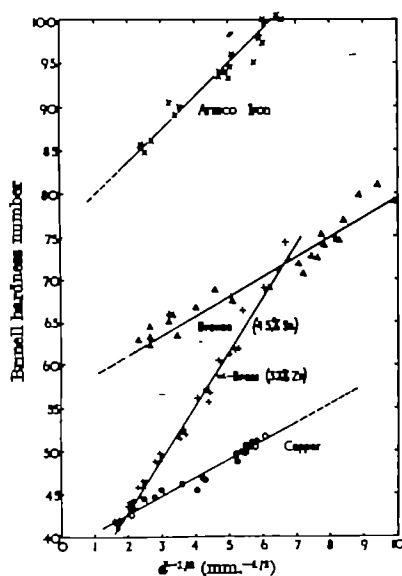


Fig. 1

plot of hardness number against $1/d^{1/2}$ gave equally 'good' straight lines, since the scatter in the original results was rather high, and in one case (α -brass) an even better fit was obtained (Fig. 1).

An interpretation of the results then appears possible, following the treatment of the variation of the lower yield stress in mild steel with grain size, which obeys a similar law⁴. When an indentation is made in a metal surface, the size of the indentation can only increase by plastic yielding in the surrounding grains. The transmission of deformation from one grain to another can be pictured on the following model: assume dislocations to pile up against a grain boundary, then the stress σ at a distance x ahead of the dislocation nearest to the grain boundary is given by

$$\frac{\sigma}{\sigma_0} \approx \left(\frac{L}{x}\right)^{1/2},$$

where σ_0 is the applied stress, and L is the length of the glide plane⁵. The adjacent grain will yield when σ reaches a certain critical value, and, identifying L with the mean grain diameter d , we find

$$\sigma_0 \propto \frac{1}{d^{1/2}}.$$

Thus all grains supporting a stress equal to or greater than σ_0 will have yielded, and assuming the extent of the plastically deformed zone is proportional to the size of the impression, the hardness will vary as $1/d^{1/2}$.

Alternatively, this analysis shows that the (local) yield stress varies with the grain size, and since Tabor⁶ has shown that the Brinell hardness is proportional to the yield stress, the same result follows.

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Inhibition of Glucose Use in Muscle Extracts by Lipoproteins

FOLLOWING the demonstration that the serum of severely diabetic rats inhibited the uptake of glucose by the rat diaphragm¹ and the later finding that such inhibition was dependent on the lipoprotein content of the serum², it was decided to test the effect of lipoprotein fractions obtained from diabetic plasma, the anterior pituitary and other tissues on the utilization of glucose by cell-free muscle extracts.

The lipoproteins used have been obtained either by alcohol fractionation of plasma³ or by flotation in the ultracentrifuge at an appropriate specific gravity, the lipoprotein being removed and precipitated with zinc for purposes of storage. In the earlier experiments the lipoproteins were dissolved and then dialysed against several changes of saline; but as the possibility had to be considered that zinc ions may be inhibiting some enzymes in the system⁴, in the more recent series reported here (Table 1) versene (ethylenediaminetetraacetic acid) has been used to bind the cation, or else zinc has been removed by passage through an appropriate ion-exchange resin prior to dialysis. All extracts were tested for zinc content with dimethylthiocarbazon, and under the experimental conditions used the maximum concentration of zinc in the system was less than 1×10^{-7} M.

The effect of such fractions has been tested on a standard system consisting of: glucose, 1.2 micromoles; muscle extract, 0.2 ml. (1 gm. muscle extracted with 1 ml. saline and adjusted to pH 7.45); phosphate buffer (pH 7.45), 10 micromoles; adenosine triphosphate, 5 micromoles; Mg^{++} , 5 micromoles, the appropriate amount of lipoprotein solution and water to a total volume of 0.7 ml. The system was incubated for 15 min. at 37°C. and glucose determined after deproteinization.

The glucose utilized has been calculated by difference between experimental results and incubated systems containing no adenosine triphosphate. The results obtained are shown in Tables 1 and 2. As the fraction obtained by alcohol fractionation of plasma is contaminated by other proteins, the quantity used is expressed as ml. of original plasma.

In addition to the experiments shown in the tables a large number of other experiments have been made with minor variations in technique. In all cases inhibition of the system by lipoprotein has been demonstrable, although with plasma lipoproteins the amount required to produce inhibition varies considerably from sample to sample. One of the most marked features has been the minute quantity of anterior pituitary lipoprotein which has produced well-marked inhibition, as little as 3 μ gm.

Table 1. INHIBITION OF GLUCOSE USE BY LIPOPROTEIN* FROM PLASMA OF DIABETIC RATS

Exp. No.	Quantity LP added (as equiv. original plasma in ml.)	Glucose utilization in μ gm.		
		Control	With LP	With LP + It†
1	0.4	117	90	100
2	0.4	181	140	144
3	0.2	104	76	100
4a	0.4	126	38	35
4b	0.4	128	38	55
5	0.6	110	90	90
6	0.4	143	96	97
7a	0.08	156	143	180
7b	0.2	156	139	135
7c	0.4	156	120	118
8	0.4	78	36	84
9	0.4	125	80	103

* Lipoprotein freed of zinc prior to use. † Insulin, 0.1 unit per ml.

Table 2. INHIBITION OF GLUCOSE USE BY TISSUE LIPOPROTEIN

Exp. No.	Source of lipoprotein	Quantity LP added as μ gm. protein	Glucose utilization in μ gm.		
			Control	With LP	With LP + I
1	Ant. pituitary, ox	3	137	131	123
		8	137	119	119
		16	139	74	84
		32	139	59	54
2	Ant. pituitary, ox	3	100	91	97
		8	100	77	88
		16	100	70	68
		32	100	47	54
3	Ant. pituitary, ox	3	126	97	106
		8	126	75	81
4	Liver, rat	16	118	83	78
		32	118	54	53
5	Muscle, rat	16	118	92	94
		32	118	68	72

being effective on a number of occasions. However, pending the demonstration of hormonal activity in such preparations, it would be premature to draw conclusions as to the physiological role of lipoprotein fractions in the control of carbohydrate metabolism.

In view of the proposal that insulin may influence glucose utilization directly¹, the effect of insulin upon the lipoprotein inhibition was explored; the insulin, where present, was 0.1 unit per ml. Most irregular results were obtained, as recorded in Tables 1 and 2. The irregularity is best shown in Table 1, where in Exp. 4 the same materials were used at 4-hr. intervals and the second test showed an apparent insulin effect but the first did not; again, in Exp. 7, with three tests done simultaneously, an insulin effect was obtained in one, but not in the other two. Altogether, in forty-two experiments done recently, a reversal of the inhibition by insulin was observed in twelve. Other proteins were tested in place of insulin, namely, insulin inactivated by alkali, glucagon, hyaluronidase, and serum albumin; in no instance was reversal of lipoprotein inhibition observed. However, in view of the irregularity of insulin effects, it is not possible to state whether this is of significance in a small series. For the same reason, no conclusions can be drawn at present as to whether such a mechanism is concerned with the physiological action of insulin.

In summary, lipoproteins from plasma, anterior pituitary, liver, and muscle have been found to inhibit glucose utilization by muscle extracts. Insulin reversal of this inhibition has been observed in a limited number of experiments.

This work, which was initiated by the authors in the Department of Biological Chemistry, Washington University, St. Louis, is being continued, and full details will be published elsewhere.

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Fibrogenesis in Connective Tissues

WHILE it is now generally accepted that the cell plays a dominant part in the fibrogenesis in connective tissues, the mechanism of the formation of the fibrils of collagen and those of elastic tissue and cartilage is completely unknown. The object of this communication is to direct attention to the presence of sub-microscopical filaments in the cytoplasm of fibroblasts, osteoblasts, osteocytes and chondroblasts. The present observations were made with the electron microscope and using ultra-thin sections of tissue.

Sections of normal thickness for study in the light microscope and the much thinner sections for the electron microscope were each prepared from the middle segment of the metatarsal rudiment of embryonic fowls of age 4-15 days, and from the mandible of 7-12-day embryos. All specimens were fixed in 1 per cent osmium tetroxide at pH 7.4¹ and embedded in ester wax over *n*-butyl alcohol and chloroform. The specimens for electron microscopy were mounted on a standard coated grid and viewed in a Metropolitan-Vickers electron microscope Type EM3 at 75 kV., a 30- μ or 60- μ objective aperture being used.

The control sections show that at about the sixth day of incubation the cells which surround the cartilaginous shafts of the metatarsus differentiate into an outer fibroblastic and an inner osteoblastic layer. In electron micrographs of transverse sections of this central hypertrophic region, the cytoplasm of the osteoblasts is seen to be packed with long fine filaments about 120 Å. in diameter, some of which enlarge to about 500 Å. in diameter in later development (Fig. 1). The filaments often lie in pairs, and each appears to be joined to its neighbour by short junctions at intervals of about 700 Å., while others seem to be twisted together into a complex helix. These single and composite filaments are usually parallel to each other and are separated by distances of 200-1000 Å.; they are also associated with mitochondria and in some cells seem to be woven around the latter.

As the age of the fowl embryo increases, the innermost layer of osteoblasts becomes sharply defined from the adjacent cartilage by a narrow dense strip which indicates the first stage of ossification. Where the cytoplasm of the osteoblasts is in immediate contact with this periosteal bone, no dividing line between the developing matrix and intracytoplasmic filaments can be distinguished; it appears that the filaments become part of the bone matrix. At present the mechanism whereby the organic matrix is laid down is not understood, as round electron-dense particles which may be related to the deposition of mineral salts are scattered throughout the region, and this quickly renders the bone matrix opaque to the electron beam.

Similar, though fewer, intracytoplasmic filaments have been observed in osteocytes of the periosteal bone, in osteoblasts and osteocytes of endochondral and membrane bone, in fibroblasts of the perichondrium and of tendon sheaths, and in chondroblasts of the hypertrophic cartilage in long bones and in the ossifying articular region of Meckel's cartilage. In the last, only single, long, well-separated filaments have so far been recorded; the other types of fibrogenic cells contain mainly short filaments and particles, and only a few contain long orientated filaments. The appearance of the micrograph, even in a cell

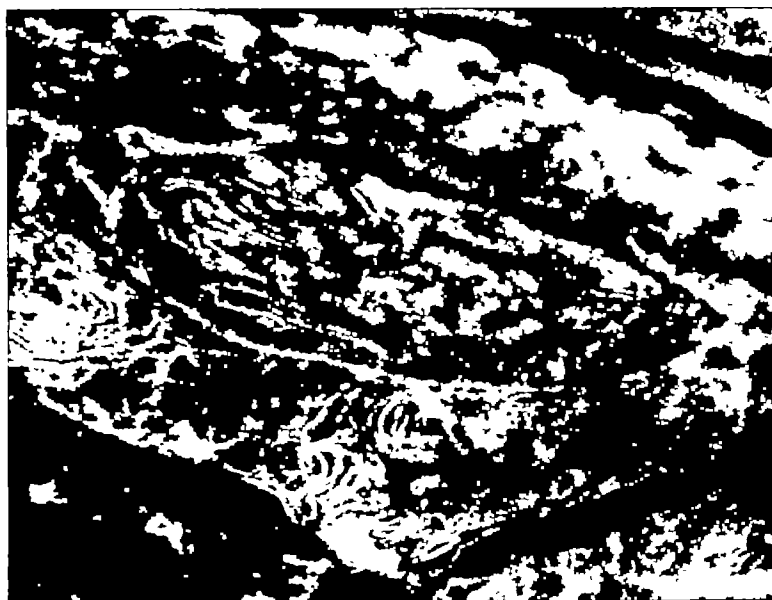


Fig. 1. Electron micrograph of a section through the osteoblastic layer of the periosteum which lies adjacent to the developing periosteal bone in the metatarsus of an 11-day fowl embryo. The cytoplasmic regions are packed with filaments, while electron-dense particles can be seen in the osseous sheath visible in the upper part of the photograph. $\times 14,000$

with well-aligned filaments, varies according to the plane of section with respect to the orientation of the filaments, and the orientation itself varies from cell to cell.

It is striking that in transverse sections of the metatarsus, that is, in sections cut at right angles to the long axis of the bone rudiment, the osteoblasts of the periosteum display long intracytoplasmic filaments which are parallel to one another and lie precisely in the plane of the section. It is possible that this orientation has been brought about by subjection of the tissue to tension during growth, for the layer of osteoblasts may be compressed between the outer fibrous coat of the periosteum and the expanding cartilage of the shaft¹. Longitudinal sections cut tangentially through the osteoblastic layer show similar precisely aligned filaments. But in longitudinal sections cut through the long axis of the shaft intracytoplasmic filaments are not observed in the osteoblasts; instead, the cytoplasm shows granules with no precise orientation which may well represent the filaments in cross-section. These observations indicate that the long axis of the filaments in the cytoplasm lies at right-angles to the length of the bone rudiment and that the filaments are arranged in layers within the osteoblasts of the periosteum.

The use of thin sectioning techniques during the past few years has added much to our knowledge of cytoplasmic content and submicroscopical structure². The observations have been interpreted in various instances to indicate the presence of lamellae, tubules and double membranes. Such structures appear to be associated particularly with the basophilic regions of protein secretory cells. Careful examination of hundreds of micrographs strongly indicates that the cytoplasm of all the fibrogenic cells which have so far been investigated contains filamentous bodies; the observations are not at present consistent with the presence of membranes or tubules. There is thus no obvious reason at this stage for relating the cytoplasmic structures of the

cells concerned in collagen formation with the intracellular structures occurring in secretory cells of the perenchyma.

The presence of intracellular cytoplasmic filaments in fibrogenic cells does not in itself establish that such structures play a direct part in fibrogenesis. The absence of any visible demarcation between the osteoblasts and the periosteal bone (Fig. 1), and the close resemblance of the cytoplasmic filaments and the intercellular fibrils of the bone matrix, suggest that the filaments may become extracellular. Further work in progress will show whether this hypothesis is correct. An attempt is also being made to determine the chemical nature of the intracellular filaments. This also should have an important bearing on the mechanism of fibrogenesis in connective and skeletal tissues.

I am indebted to Dr. H. B. Fell, Prof. J. T. Randall and Dr. W. Jacobson for their continued advice and encouragement.

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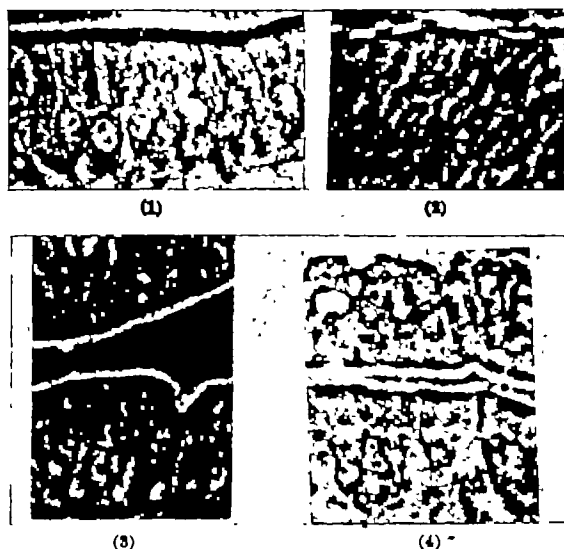
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Phase-Contrast Microscopy of the Gomori Reaction for Alkaline Phosphatase

In the standard Gomori technique for the histochemical demonstration of alkaline phosphatase, calcium phosphate deposits are formed in sections supposedly at sites of enzyme activity. These deposits, thought to be invisible, must be brought to light by a further procedure. Calcium may be converted to cobalt and the latter visualized as the black sulphide; the von Kossa silver technique may be employed; or lake-forming dyes may be used for colouring the deposits.

We have carried out experiments using paraffin sections of alcohol-fixed duodenum from young rats. Following incubation in substrate¹ in the usual way, we have rinsed the slides in distilled water buffered at pH 9.20 with sodium barbital, dehydrated, and mounted them direct in Canada balsam without any further treatment. We have studied their appearance with the phase-contrast microscope and have observed progressive changes in the appearance and optical properties of the sections as incubation proceeds. The changes do not take place in sections incubated in a substrate bath lacking phosphate ester or in sections heated to destroy intrinsic enzyme prior to incubation.

Control sections were dewaxed, taken to buffered water for 2 min., dehydrated and mounted. Compared with these, after 1-min. incubation the brush



(1) 1-min. incubation. The epithelial free border appears dark (phase positive) and striations may be distinguished. (2) 2-min. incubation. Striation is no longer visible. Two phase-negative areas are present in the border, separated by a phase-positive zone. To the right, the border is almost invisible. (3) 4-min. incubation. The border is now continuously phase negative. In the upper portion it contains minute 'pre-crystals' while, in the lower part, larger (black) crystals are to be seen slightly out of focus. (4) 16-min. incubation. The border is filled by a shining, solid mass of crystals.

Phase-contrast photographs. $\times 750$

border of the cells appears slightly darker and more clearly striated (Fig. 1). After 2 min. the optical properties of the border are affected in a patchy manner. In some places it remains darker than the background (that is, phase positive); in others, it becomes invisible; while elsewhere, transmitting more light than the background, it becomes markedly phase negative (Fig. 2). Minute phase-negative crystal-like structures ('pre-crystals') can just be resolved within such areas; but striation is no longer visible. After 4 min. the border is continuously phase negative and, in addition to 'pre-crystals', quite large, shining crystals appear (Fig. 3). These increase rapidly with time until after 16 min. they form an almost solid mass which fills the border completely (Fig. 4).

If the coverslip is removed from such a section and the slide is remounted in bergamot oil instead of Canada balsam, the phase-changes and 'pre-crystals' can no longer be seen. The border appears dark, without 'pre-crystals'; the crystals also are more difficult to define. If the section is once again mounted in balsam, it reverts to its original appearance. Bergamot oil has a lower index of refraction than Canada balsam. This suggests that the reversal of phase behaviour is due, not to a simple loss of substance from the section during incubation, but to alterations in the refractive index of its different parts resulting from the superimposing of some material thereon during incubation. The phase-changes, the 'pre-crystals' and crystals are all abolished by brief immersion in dilute mineral acids; moreover, gypsum crystals can be seen to form over the border when a drop of melted glycerine jelly acidified with sulphuric acid is added. These facts suggest that, as might be expected, the material deposited and responsible for the phase-changes and crystal formation is in fact calcium phosphate.

We are studying the effects of longer incubation periods, the behaviour of other tissues and freeze-dried material, with the object of comparing the

localization of sites of enzyme activity indicated by this new method with the classical techniques.

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Silk-Phosphoric Acid Solutions

NATURAL silk is readily soluble in several solvents, such as cupriethylenediamine, lithium bromide and lithium rhodanide, phosphoric acid, etc. Generally, it is assumed that the dissolution is brought about in such a way that the solvent splits the hydrogen-bonds which intermolecularly connect adjacent fibroin chains, attaches itself to the positions now made available and thus transforms the fibroin into a hydrophilic, water-soluble modification. Schauenstein¹ stated that this procedure could be followed by means of ultra-violet spectroscopy by virtue of the 'peptenol' chromophore, the intensity of which should be a measure of the intermolecular hydrogen-bonding, and which shows a distinct and specific absorption in the region of about 250 m μ . In the course of regeneration experiments with phosphoric acid solutions, different silk samples were investigated in a Beckman spectrophotometer, namely, natural silk, silk dissolved in phosphoric acid (diluted with water), the aqueous silk solution obtained by dialysing the phosphoric acid solution and, finally, films prepared by drying the aqueous solution. The absorption curves obtained are shown in Fig. 1. In view of the above considerations, this result would mean that natural silk contains by far the largest amount of intermolecular bonds, whereas the phosphoric acid solution has lost most of them. Yet the aqueous solution shows an increase in the hydrogen-bonding, and still more so does the film, although without reaching the high value of natural silk.

Independently of this problem, the question arises whether all the solvents mentioned cause decomposition of the silk molecule or not. Howitt² claimed that

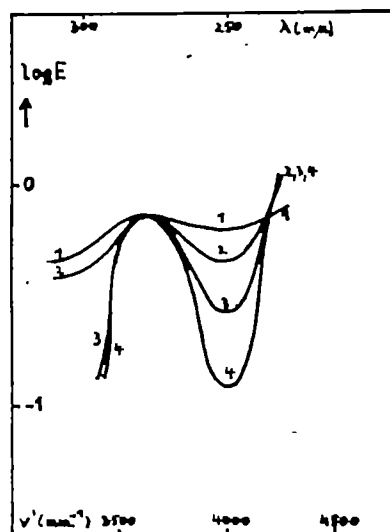


Fig. 1. Ultra-violet spectrograms of silk samples: (1) natural silk; (2) silk film prepared from aqueous solution; (3) aqueous silk solution; (4) phosphoric acid-silk solution.

cupriethylenediamine does not do so; but Signer³ has recently doubted that statement. Lithium bromide⁴ and lithium thiocyanate⁵ seem to maintain the original molecular weight. We have examined the phosphoric acid solutions by means of viscosity measurements extending over a period of 30 hr. It was found that a noticeable decrease of intrinsic viscosity takes place, as shown in the table.

Time	$[\eta]$
10 min.	1.13
5 hr.	0.82
25 hr.	0.54

This decrease in viscosity may be caused by either a molecular rearrangement (folding of chains) or by an actual decomposition of the silk molecule; or by both these effects. Although a decision based on these results is not possible, to us the second explanation (decomposition) seems the more probable one. It might also explain the numerous difficulties encountered when trying to spin useful fibres from phosphoric acid solutions⁶.

Finally, one further observation should be mentioned. If the process of dissolving silk in phosphoric acid is observed under the microscope, it is seen that the acid first attacks the fibre at regularly spaced positions, thus after a few seconds creating the impression of a dotted line (with segments of about 100 μ m length). A few minutes later complete dissolution is achieved.

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Synthesis of Oligosaccharides during Enzymatic Hydrolysis of Cellobiose by *Aspergillus flavus*

DURING our investigations on the synthesis of oligosaccharides from simple sugars by various mould extracts it was found that the mycelial extract of *Aspergillus flavus* was capable of synthesizing oligosaccharides from cellobiose. The dialysed extracts of the mould converted cellobiose into glucose and four other saccharides, three of which occupy positions below cellobiose and one between cellobiose and glucose on the paper chromatogram. Similar observations were reported recently by Crook and Stone¹ by the action of *Aspergillus niger* on cellobiose. The substances were not identified. Barker *et al.*² have recently reported the synthesis by *Aspergillus niger* (strain 152) of some oligosaccharides which were identified as β -linked glucosaccharides. In view of the importance of this reaction in carbohydrate metabolism and in the mechanism of the synthesis of oligosaccharides, we report in this communication the results obtained on the identification of the substances formed from cellobiose.

Dialysed extract (5 c.c.) of *Aspergillus flavus* was added to a mixture containing 5 c.c. of 20 per cent cellobiose in 0.02 M acetate buffer (pH 5.0) and



Fig. 1. Semicircular chromatogram showing the separation of glucose and oligosaccharides formed after 15 days of incubation of cellobiose with the mycelial extract of *Aspergillus flavus*. Solvent: butanol-pyridine-water (60:40:30); reagent: aniline-hydrogen phthalate; Whatman No. 3 (25 cm. diam.). Double development.

1, Oligosaccharide (1); 2, oligosaccharide (2); 3, gentiobiose; 4, cellobiose; 5, unidentified band; 6, glucose

incubated at room temperature (21–24° C.). Aliquots were removed at known intervals and the sugars and oligosaccharides formed were separated and identified by circular paper chromatographic technique³ according to the procedure recently reported for the separation of sugars⁴. Butanol-pyridine-water (60:40:30) and butanol-acetone-water (20:70:10) were used as solvents and aniline-diphenylamine-phosphoric acid⁵ and aniline-hydrogen phthalate⁶ as reagents. Fig. 1 shows the chromatogram of the saccharides formed after fifteen days of incubation. The oligosaccharides were identified by running multisector chromatograms of the digest and a mixture of cello-dextrins obtained by deacetylation⁷ of cellulose acetolysate⁸ and gentiobiose, which was kindly supplied by Dr. W. J. Whelan, of the University College of North Wales, Bangor. It was observed that during the first 18 hr. of incubation glucose and the oligosaccharide (2) were formed, followed by the formation of oligosaccharide (1) after 72 hr. On the eighth day of incubation the oligosaccharide (3) was formed and its concentration increased at later stages. A faint band (4) appeared at the initial stages which did not increase in intensity after fifteen days of incubation. Only one of the oligosaccharides (1) corresponded with a cello-dextrin occupying the position below cellobiose on the chromatogram. The oligosaccharide (3) occupied the same position as that of gentiobiose and isomaltose. All the oligosaccharides showed reducing action towards the reagent triphenyl tetrazolium chloride. Complete hydrolysis of the oligosaccharides (1) and (2) after elution from the paper yielded glucose as the only product.

These observations indicate the occurrence of enzymes in the mould, which synthesize oligosaccharides from cellobiose by the same mechanism of transglucosidation as suggested by Pazur and French⁹ for the synthesis of oligosaccharides by the enzymic action of fungal cultures on maltose. The enzymes of *Aspergillus flavus* convert cellobiose into glucose and oligosaccharides (1) and (2) which appear in the initial stages and also convert cellobiose into gentiobiose, a conversion similar to that of maltose into isomaltose by *Penicillium chrysogenum*—Q176¹⁰ and other moulds¹¹. The gentiobiose was identified provisionally from the study of the R_f values of the substance in various solvents, the reducing action and colour reactions with aniline-diphenylamine-phosphoric acid, which was found to be a useful reagent for differentiation of sugars with 1–4 and 1–6 glycosidic linkages¹². Further work on the isolation and characterization

of the oligosaccharides and the enzymes is in progress and will be reported in a later communication.

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Absorption of Phosphorus-32 from the Rabbit Vagina under Various Hormonal Conditions

It has been known for a long time that the vagina of different animals absorbs many substances, for example, poisons of various kinds, dyestuffs, semen, etc. (for references see Bengtsson¹). As the condition of the vagina is influenced by oestrogenic hormone, it is to be expected that this hormone will also influence the absorption capacity of the vagina. Baker² found in rats that the absorption of potassium ferrocyanide from the vagina changes during the course of the sexual cycle, being slowest in oestrus and most rapid in oestrated animals, that is, the absorption varies directly with the thickness and the cornification of the vaginal squamous epithelium. The following investigation was carried out in order to elucidate the influence of oestrogens on the vaginal absorption in animals with no impeding epithelium (that is, with a columnar vaginal epithelium).

Through a soft rubber catheter, 0.5–1.0 mc. phosphorus-32 in the form of disodium hydrogen phosphate was injected into the vagina of an anaesthetized rabbit. The isotope was diluted with normal saline to 2 ml.; 1.0 mc. corresponded to 100 μ gm. phosphorus. After withdrawal of the catheter, the vaginal opening was carefully closed by a soft clip. Immediately before the injection, the urinary bladder was emptied by pressing on the abdomen, and the vagina was repeatedly washed with normal saline. At various intervals (5, 10, 20, 30, 40, 70 and 120 min.) after the injection of phosphorus-32, about 1 ml. blood was removed from the ear vein and immediately centrifuged. Of the plasma, 0.1 ml. was pipetted on to an aluminium plate and the radioactivity determined by means of a Geiger-Müller tube and an electron counter. The absorption curves thus obtained were adjusted to equal height.

Thirty-six rabbits were used, eighteen of which were castrated and untreated, four were castrated and subcutaneously injected with about 5,000 i.u. oestrone in water solution ('Menformon' Pharmacia) daily for a week, four were castrated and intravenously injected with a single dose of oestrone (5,000 i.u. of the same hormonal preparation) one hour before the phosphorus-32 injection, and ten animals were normal controls (that is, not castrated). Ovariectomy was performed one to two weeks before

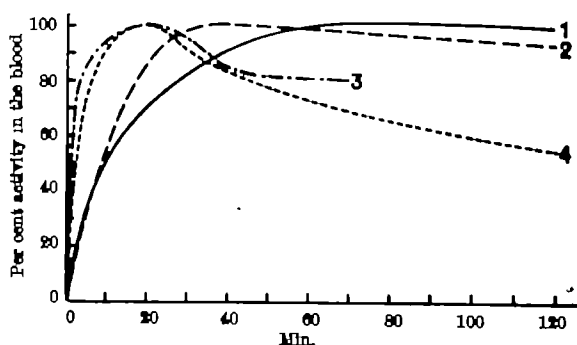


Fig. 1. Per cent radioactivity in the blood at various times after vaginal application of phosphorus-32. Curve 1, castrated, non-treated rabbits; curve 2, normal rabbits; curve 3, castrated rabbits, injected intravenously with oestrogen one hour before the vaginal application of phosphorus-32; curve 4, castrated rabbits, injected subcutaneously with oestrogen daily for a week before the vaginal application of phosphorus-32.

the experiments. The curves in Fig. 1 show the mean values for the different observations in the four groups.

The castrated, untreated animals (curve 1) have a slow vaginal absorption with maximum activity in the blood about 70 min. after the injection of phosphorus-32. Normal rabbits (curve 2) have a somewhat more rapid absorption, with maximum activity after about 40 min. The oestrogen-treated animals (curves 3 and 4) show the most rapid absorption, with maximum activity only about 10–20 min. after injection of phosphorus-32.

One hour after stimulation by oestrogen, the vaginal absorption was thus considerably increased. This rapid action of oestrogen on the vaginal absorption is in full agreement with other rapid oestrogenic effects on the vagina, for example, vasodilatation³ and permeability of the cell membrane to phosphate⁴.

The increase in the rate of vaginal absorption after hormonal stimulation may well be due to more than one reason: (1) the above-mentioned vasodilatation; (2) the increased penetration of phosphate through the cell membrane; and (3) possibly also an increase of the absorption surface, that is, a dilatation of the vagina. From the experiments it is impossible to know how the increase in phosphate absorption is brought about. But it seems probable that the hormonal effect on the cell membrane plays an important part. (In several other experiments, oestrogen was given intravenously at various times after the injection of phosphorus-32 in order to investigate whether a rapid increase of absorption could influence the slope of the activity curve. However, no conclusions could be drawn on this point.)

The similarity of the absorption curves for the groups treated one hour and one week before application of phosphorus-32 is surprising. The effect of oestrogen on the factors which regulate absorption (vasodilatation, phosphate penetration, etc.) can scarcely reach a maximum within one hour after hormonal stimulation. Possibly the increasing oedema and the production of mucus in the cells of the vaginal mucous membrane again decrease the absorption. This would be parallel to the observation in rats by Baker mentioned earlier²: the increasing cornification of the vaginal epithelium during oestrus diminishes the absorption.

It is curious that the activity in the blood in untreated normal and untreated castrated animals is practically unchanged from 40 to 120 min. after

the injection of phosphorus-32. The vaginal route of application of radiophosphorus in rabbits therefore represents a means of getting a stable activity in the blood; the slopes of the individual curve are, however, so variable that the method is somewhat uncertain.

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Marine Invertebrate Preparations useful in the Bioassay of Acetylcholine and 5-Hydroxytryptamine

CERTAIN isolated muscle and heart preparations of marine invertebrates are highly sensitive to acetylcholine, to 5-hydroxytryptamine (enteramine, serotonin), or to both of these substances. Bao¹ was the first and Ambache and Sawaya² among the more recent to demonstrate the sensitivity to acetylcholine of muscle strips from holothurians (Echinodermata). Inhibition of heart-beat of the bivalve mollusc, *Venus mercenaria*, was first used by Welsh³ for the quantitative estimation of acetylcholine in tissue extracts. Recently, the same heart has been found to respond by increases in amplitude and frequency to low concentrations of 5-hydroxytryptamine⁴. Earlier, it had been reported^{5,6} that certain molluscan hearts had a low threshold to 5-hydroxytryptamine or tissue extracts containing this substance. At the Marine Biological Laboratory, during the summer of 1953, the need arose for the quantitative estimation of acetylcholine and 5-hydroxytryptamine in certain tissues. Several species of echinoderms and molluscs from the Plymouth region were secured, and isolated muscle and heart preparations were screened for their suitability in bioassay of these substances. Available holothurians were *Holothuria nigra*, *Oucumaria normani*, *O. elongata*, and a single specimen of *Thyone* sp. Pieces or entire lengths of the longitudinal muscle bands were dissected free from the inner body wall and set up in the manner commonly used for muscle strips during recording of contractions. In the case of *O. normani* the peristomal (pharyngeal) retractor muscles were also tried. While all these preparations contracted in low concentrations of acetylcholine, especially after eserization, the difficulties that were encountered by earlier workers^{1,7} who had used other species of holothurians were obvious. Chief among these were spontaneous contractions, tendency to contract and remain contracted after eserine, and sensitivity to mechanical stimulation after eserine. This last was especially marked in the muscles from the single specimen of *Thyone* which, otherwise, were most promising since they were not spontaneously active.

Of these holothurians from the Plymouth region, *H. nigra* was considered most suitable. Its longitudinal body-wall muscles responded to as little as 5×10^{-9} gm./ml. acetylcholine chloride before eserine and often were not spontaneously active. The response to acetylcholine was nearly maximal at 10^{-7} gm./ml. Although a low concentration of eserine (10^{-8} gm./ml.) produced or increased spontaneous activity, it lowered the threshold to acetylcholine about a hundred-fold. When an acetylcholine con-

traction was superimposed on minimal spontaneous activity, a satisfactory quantitative measure of action was obtained. Isolated muscles of *H. nigra* were kept for twenty-four hours in aerated sea-water and there was little or no change in sensitivity to acetylcholine. The responses of holothurian muscle to 5-hydroxytryptamine were not observed.

Hearts from *Pecten maximus*, *Modiolus modiolus*, *Cyprina islandica* and *Buccinum undatum* were tested for their sensitivity to acetylcholine and 5-hydroxytryptamine. The heart of *Pecten* was cannulated and perfused *in situ* and also isolated and perfused. Much difficulty was encountered in maintaining a heart with a regular beat for an adequate period of time, and the sensitivity to acetylcholine and 5-hydroxytryptamine was low. The hearts of *Modiolus* and *Cyprina* were isolated and suspended in a bath, without cannulation, after the method employed with the heart of *Venus mercenaria*³. The *Modiolus* heart had a regular beat that held for many hours, but it was extremely insensitive both to acetylcholine and 5-hydroxytryptamine. In one instance no inhibition with acetylcholine was obtained at a concentration of 10^{-6} gm./ml. and no measurable excitation with 5-hydroxytryptamine at 10^{-7} gm./ml. Higher concentrations were not tested.

Three different hearts of *Cyprina* were tested. All beat at a slow rate but with a regular rhythm. The threshold dose of acetylcholine was about 5×10^{-10} gm./ml. With increasing doses the heart-rate was slowed in a graded manner; but there was no graded decrease in amplitude. At about 10^{-8} gm./ml. the heart stopped beating. The beat was quickly restored on washing. Eserine failed to potentiate the action of acetylcholine significantly. The *Cyprina* heart responded to 5-hydroxytryptamine with an increase in amplitude and frequency. Threshold was near 10^{-10} gm./ml. and a graded action was obtained up to 10^{-6} gm./ml.

On the *Venus* heart 'Mytolon' (supplied through kindness of Sterling-Winthrop Research Institute) is the most effective known acetylcholine antagonist^{8,9}. Likewise, lysergic acid diethylamide (LSD-25) (supplied through kindness of Sandoz Products, Ltd.) is the most effective antagonist for 5-hydroxytryptamine yet found for the *Venus* heart¹¹. 'Mytolon' was found to be a highly effective antagonist for acetylcholine and LSD-25 for 5-hydroxytryptamine on the heart of *Cyprina*.

Considering relative abundance, hardness of the animals and regularity and responsiveness of the heart to the substances to be assayed, the whelk, *Buccinum*, proved most satisfactory. Hence it was used in the identification and estimation of acetylcholine and an excitator substance, probably 5-hydroxytryptamine, in molluscan tissues. A detailed account of the results will appear elsewhere. The *Buccinum* heart was removed and a cannula inserted into the ventricle, usually by way of the auricle, but sometimes by way of the aorta if the auricle was accidentally torn from the ventricle. The attachment of the thin-walled auricle to the thick-walled ventricle is delicate, and two or three separate ligatures of rather coarse thread avoided the cutting and tearing that otherwise sometimes occurred. The *Buccinum* ventricle was perfused with sea-water, as were the other molluscan hearts and holothurian muscles. It was necessary to distend the ventricle with a small head of pressure to start it beating and to introduce drugs and extracts under the same pressure used in perfusing and washing.

The *Buccinum* ventricle had thresholds to acetylcholine and 5-hydroxytryptamine near those of *Cyprina*. The response to acetylcholine, however, is a decrease in amplitude with little change in frequency. The frequency increase produced by 5-hydroxytryptamine is often accompanied by an increase in tonus. 'Mytolon' blocked acetylcholine and LSD-25 blocked 5-hydroxytryptamine, as on the *Cyprina* heart. These highly effective antagonists were used in obtaining estimates of the amounts of acetylcholine and 5-hydroxytryptamine occurring together in a given tissue. Preliminary evidence that the heart of *Venus mercenaria* has an excitatory innervation mediated by 5-hydroxytryptamine was recently presented⁴. Nerve ganglia and certain other tissues of molluscs from the Plymouth region were found to contain mixtures of heart-excitatory and -inhibiting substances. Reliable quantitative estimates could be made only when the test heart was treated with 'Mytolon' or with LSD-25 to block one or the other substance. Since leaving Plymouth, we have found by chromatography and biological tests that ganglia of *Venus mercenaria* and the whelk, *Busycon canaliculatum*, contain 5-hydroxytryptamine and acetylcholine. It is likely that these were the substances present in the tissues studied at Plymouth.

Other large molluscs were not available at Plymouth; but Prof. Brodie Hughes, at the University of Birmingham, has kindly permitted me to say that he has tested the sensitivity of the isolated heart of *Mya arenaria* to acetylcholine and has used it in the bioassay of acetylcholine in cerebrospinal fluid. A record sent me by Prof. Hughes was made in February. The record shows a decrease in amplitude of about 80 per cent when 0.005 $\mu\text{gm./ml.}$ acetylcholine was present in the bath. The decrease in amplitude with 0.008 $\mu\text{gm./ml.}$ was nearly 50 per cent and with 0.01 $\mu\text{gm./ml.}$ the amplitude was reduced to zero. Prof. Hughes has noted that *Mya* hearts become much more sensitive from the months of April to June. A similar seasonal shift in responsiveness of the *Venus* heart to acetylcholine was first noted by Prosser¹², who found them most sensitive in late winter and spring. Whether this is generally true of marine molluscs from northern waters is not known.

It is apparent from this brief survey that there are several species of marine molluscs in British waters the hearts of which may be useful in the determination and estimation of small amounts of acetylcholine and 5-hydroxytryptamine. It is also clear that there are holothurian species the muscles of which respond to low concentrations of acetylcholine.

I am indebted to the Director and staff of the Laboratory, Citadel Hill, Plymouth, for the facilities that were provided for this work.

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Life-history of the Rat Lung-worm and its Migration through the Brain of its Host

THE metastrongylid lung-worm, *Angiostrongylus cantonensis* (Chen), was described from rats at Canton¹, reported by Yokogawa from Formosa², and has been found in about 5 per cent of wild brown rats, *Rattus norvegicus* (Ersl.), in Brisbane. It is now being maintained as a laboratory infection in white rats. The life-history shows some remarkable features.

The adult worms live in the pulmonary arteries. The unsegmented ova are discharged into the bloodstream and lodge as emboli in the pulmonary capillaries. They develop there into first-stage larvae, which penetrate the alveoli, and presumably pass up the trachea and are swallowed, for they can be found in the intestinal contents and eventually pass out of the host in the faeces.

Garden slugs, *Limax* spp., act as intermediate hosts, a small, black, still unidentified, species being the best. The first-stage larvae usually penetrate the foot of the slug; but developing larvae may also be found in other parts of the body-wall and in between the internal organs. The first moult occurs in about twelve days and the second about five days later, at temperatures ranging from 70° to 79° F.

The third-stage larva remains quiescent within its two cast skins until ingested by a rat, when it is

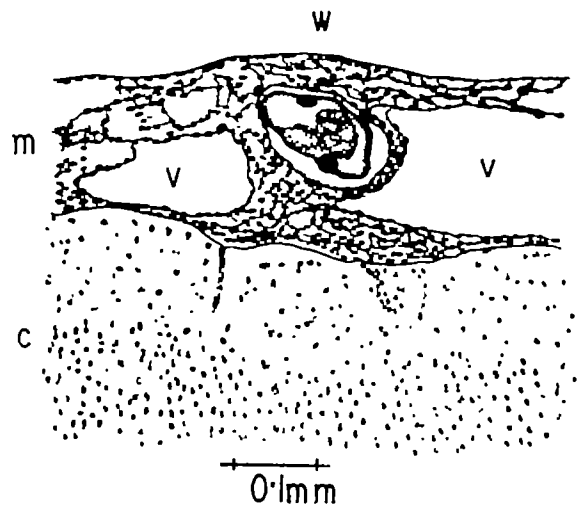


Fig. 1

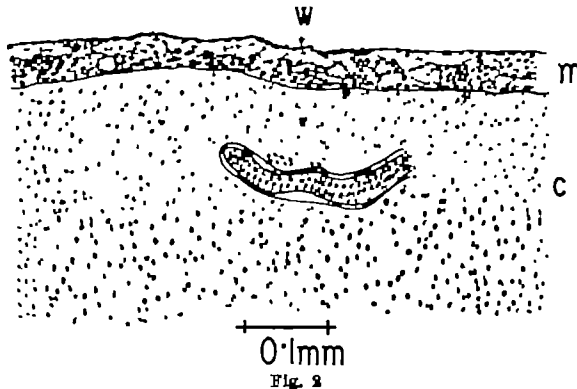


Fig. 2

Figs. 1 and 2. Tracings from photomicrographs of sections of the brains of rats. Fig. 1 is from a rat twelve days, and Fig. 2 twenty-nine days, after ingestion of infective larvae. c, cerebral cortex; w, pia-arachnoid membrane; v, section of lung-worm; e, dilated vein.

set free in the stomach and moves actively down the intestine. Larvæ have been found in the lower part of the ileum less than three hours after ingestion, and have been detected in the mesentery attached to it at this time. One was seen inside a small mesenteric vein, and it is presumed that they enter the blood-stream here.

Two days after ingestion, larvæ may be found in the grey matter of the cerebral hemispheres, particularly near the anterior pole, moving about in the cerebral tissue without causing any apparent damage (Fig. 1). They grow, and about the twelfth day the final moult occurs. The immature adults then emerge on the surface of the cerebrum, where they move about freely in the sub-arachnoid space and grow rapidly. The vessels of the pia-arachnoid become greatly dilated, and there is considerable cellular infiltration (Fig. 2).

On the twenty-ninth day after ingestion, the young adults begin their journey to the lungs. They have been recovered from the external jugular vein, left superior vena cava and right ventricle between the twenty-ninth and thirty-first days. By the thirty-second day, migration is usually complete, and all worms are found in the pulmonary arteries. Egg-laying begins a few days later, and first-stage larvæ appear in the faeces of the host between the fortieth and forty-fifth days.

The rats show no noticeable ill-effects from the quite gross lesions produced in the meninges and lungs.

This appears to be the first record of a parasitic nematode requiring a prolonged sojourn in the brain of its final host, before migrating to its definitive site at a relatively advanced stage of development. A detailed account of the work will be published elsewhere.

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Jan. 22.

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¹ Chen, H. T., *Ann. Parasitol.*, 13, 312 (1935).

² Yokogawa, S., *Trans. Nat. Hist. Soc. Formosa*, 27, 247 (1937).

Allometric Growth in the Nematoda

ALLOMETRIC growth has been studied, and shown to occur, in a large number of different animals; but the Nematoda do not appear to have been studied in this way. This is especially surprising in view of the simple shape of the parasitic members of this group and the extent to which the systematics of the group are dependent upon simple measurements of the individuals and of their constituent parts and, to a lesser degree, upon the ratios of these parts. In such cases allometric growth must be considered before too much stress is laid upon differences in ratios.

Data on the dimensions of the nematode species *Toxascaris leonina* (von Linst., 1902) have been gathered during a study of host specificity and variation within this species, and have been utilized to determine whether or not allometric growth occurs in the following cases: head and body width; growth in length of the oesophagus, the tail and the cervical alæ in relation to the body-length. The results show that allometric growth occurs in this species in all

the relationships considered except, possibly, in the cases of body-breadth and total body-length, and oesophageal breadth and oesophageal length.

In the equation for allometric growth, $y = bx^k$, the value of b is of no biological significance since it simply gives the length of y when $x = 1$ and its value is dependent upon the units used in its calculation. k , however, is of value since it indicates the differences between the rates of growth of the two parts under consideration. In Table 1 the values of k obtained for the different growth-rates compared are given.

Table 1

Relationship considered	Allometric constant
Oesophageal length : Body length	0.36
Cervical alæ length : Body length	0.41
Tail length, ♀ : Body length	0.76
Tail length, ♂ : Body length	0.59
Diameter of the head : Body length (whole)	0.46

These values of k indicate that the simple ratios of these dimensions must vary considerably in individuals of different total body-length and that such simple ratios must be treated, in systematic, with a certain amount of reserve.

The results obtained from a study of the relationships between the total body-length and body-breadth and oesophageal length and oesophageal breadth suggest that these relationships are isometric. These conclusions must, however, be treated with caution as the width of the individuals is the dimension most affected by preservation.

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Liberation of Boron from 'Pyrex' and 'Hysil' Glass in Relation to Plant Growth in Water Culture

It is well known that plants in water culture may absorb appreciable quantities of boron from glassware such as 'Pyrex' and 'Hysil', which contain borosilicates. The literature has been reviewed by Hewitt¹ in relation to water culture techniques. The possibility of contamination resulting from the use of this type of laboratory glassware in preparing culture solutions has not, however, been generally recognized.

Using the method described by Hatcher and Wilcox², it was found that the boron content of copper-distilled water which had been boiled for one hour in a 'Pyrex' flask was 0.074 p.p.m. A comparable value was found for 'Hysil' flasks, namely, 0.070 p.p.m. boron. No boron could be detected in the original distilled water.

The response of flax seedlings to water which had been boiled for one hour in a 'Hysil' flask was examined as follows: the plants were grown in 1 lb. jam jars (soda glass) containing 800 ml. of a boron-free nutrient solution. 'Hysil'-boiled water was supplied in varying amounts up to 7.33 per cent by volume of the nutrient solution, which was renewed weekly, but not aerated. Ten seedlings were grown in each jar and after three weeks growth under glass in July the dry weights of shoots and roots were determined.

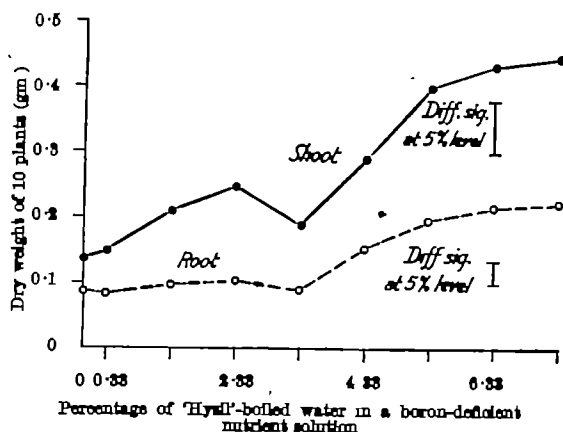


Fig. 1

The results are summarized in Fig. 1. It will be noted that where the proportion of 'Hysil'-boiled water exceeded 4.33 per cent of the total volume of nutrient solution, significant increases in the dry weights of both shoot and root resulted. The concentration of boron at this dilution of the 'Hysil'-boiled water was only 0.0030 p.p.m.

These findings arose from attempts made in this department to verify the claim of Eaton³ that β -indolyl acetic acid may, to some extent, replace boron as an essential element in plant growth. When aqueous solutions of this acid prepared in 'Hysil' vessels were added to boron-deficient nutrient solutions significant increases in the growth of flax were frequently obtained. This result can now be attributed, at least in part, to the boron liberated from the glassware.

In recent years much attention has been centred on the testing of a wide range of organic compounds for biological activity. It is now evident that where the level of boron is sub-optimal for the growth of the plant or plant organ, or is quite unknown, precautions should be observed to ensure that, in the preparations of solutions for test, no contamination with borosilicate glassware has occurred.

We are indebted to Dr. T. H. Rose and Mr. T. Williams, of the National Agricultural Advisory Service, Wye, for the boron estimations.

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J. R. RHES
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Feb. 6.

¹ Hewitt, H. J., *Teoh, Comm. 22, Commonw. Bur. Hort. Crops* (1952).

² Hatcher, J. T., and Wilcox, L. V., *Anal. Chem.*, **28**, 567 (1956).

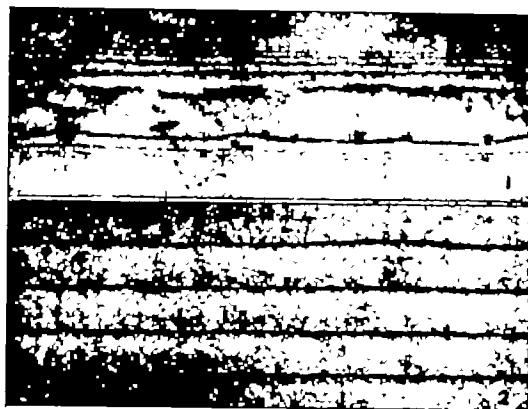
³ Eaton, F. M., *Bot. Gaz.*, **101**, 700 (1940).

Sharpening the Microtome Knife

SEVERAL articles have been written on the most suitable method of sharpening the knife of a microtome. The usual manner of sharpening is grinding, honing, polishing and stropping, and there are several different methods for each of those operations. There is obviously a lack of a quantitative measuring method by means of which the result of different sharpening methods can be tested. The only fairly reliable method still used is the one indicated by von Mohl¹.

The edge of the microtome knife is formed by the line of intersection of the facet surfaces. Decisive for the quality of the knife are evenness and surface finish. Therefore, a good sharpening method must result in both these qualities for the facet surfaces. Just as important is a measuring method which gives an absolute measurement of the sharpening result.

A machining method which satisfies the highest demands of evenness and surface finish of steel is lapping against cast-iron. This method is, as a rule, used by the measurement workshops in factories where precision goods are manufactured. It has proved extremely advantageous for the purpose of sharpening microtome knives. Owing to its speed with regard to removing the material and its performance with regard to the evenness and surface finish, it alone can replace grinding, honing, polishing and stropping.



By means of multiple interference microscopy, according to Ingelstam², it is possible to check the machined facet surfaces quantitatively. By using this method, deficiencies in evenness and surface finish can be measured to an accuracy of about 50 Å. The result of different sharpening procedures can thus be given in absolute measurement. The facet surface of a microtome knife direct from the factory (Fig. 1), and a lapped knife (Fig. 2), are shown on the accompanying interferograms ($\times 600$). The interference fringes give a direct profile curve of the facet surface. The new knife shows signs of machining at a depth of 2000 Å, that is, rather a good surface finish but, on the other hand, variations in evenness of about 3000 Å longitudinally and finally a considerable curving of the facet surface, which means that the clearance angle of the knife can never be adjusted against the block of tissue. The figures corresponding to the lapped surface are 50–200 and 500 Å, respectively.

A more detailed report of this method will be published later.

I am indebted to Mr. Erik Gislén, chief engineer, and the SKF Factory, Göteborg, for their kind assistance and for the facilities placed at my disposal which made it possible to carry out this investigation. The cost of the investigation was defrayed by grant from the Swedish Medical Science Research Council.

O. HALLÉN

Department of Histology,
Faculty of Medicine,
Göteborg C. Jan. 30.

¹ Mohl, H. v., *Bot. Z.*, **18**, 248 (1857).

² Ingelstam, H., *Reports from the Laboratory of Optics, Royal Inst. of Technology, Stockholm, Sweden*, No. 14 (1951).

FORTHCOMING EVENTS

(Meetings marked with an asterisk * are open to the public)

Monday, May 17

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.O.1), at 5.30 p.m.—Prof. Wilfrid V. Quine: "The Nature of Mathematical Truth".

UNIVERSITY OF LONDON (at Guy's Hospital Medical School, St. Thomas Street, London, S.E.1), at 5.30 p.m.—Dr. B. Brodie (U.S.A.): "Biochemical and Clinical Implications of Studies in Drug Metabolism". (Further Lecture on May 19.)

UNIVERSITY OF LONDON (at Queen Mary College, Mile End Road, London, E.1), at 5.30 p.m.—Prof. Werner Fenchel: "Duality in the Theory of Convex Functions". (Further Lecture on May 18 at above address, and on May 21 at University of London, Senate House, London, W.O.1.)

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.O.2), at 6 p.m.—Dr. Henry Phillips: "The Chemistry of Leather". (Cantor Lecture.) (Further Lectures on May 24 and 31.)

Monday, May 17—Thursday, May 20

ILLUMINATING ENGINEERING SOCIETY (at the Town Hall, Torquay)—Twenty-ninth Annual Conference: "Electricity and the Country-side".

Monday, May 17—Friday, May 21

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.O.2), at 6 p.m.—Dr. Henry Phillips: "The Chemistry of Leather". (Cantor Lecture.) (Further Lectures on May 24 and 31.)

Tuesday, May 18

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.O.2), at 5.15 p.m.—Sir William Halcrow: "Engineering Developments in Central Africa".

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Annual General Meeting. Mr. W. Leonard Hill: "Making Known" (Chairman's Address).

UNIVERSITY OF LONDON (at the Institute of Archaeology, Inner Circle, Regent's Park, London, N.W.1), at 8.15 p.m.—Mr. A. Digby: "Recent Work in Archaeology outside Europe", (2) "Central America".

Tuesday, May 18—Friday, May 21

ILLUMINATING ENGINEERING SOCIETY (at Southport)—Summer Meeting.

Wednesday, May 19

PHYSICAL SOCIETY and the INSTITUTE OF PHYSICS (in the Physics Lecture Theatre, University College, Gower Street, London, W.O.1), at 4.15 p.m.—Joint meeting on "Electron Physics".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Scientific Papers.

ROYAL SOCIETY OF MEDICINE, COMPARATIVE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5 p.m.—Annual General Meeting, followed by discussion on "Physiological and Pathological Aspects of Locomotion in Man and Animals".

SYNTHETIC ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Colloquium on "The Species Concept in Palaeontology".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.O.1), at 5.15 p.m.—Mr. J. Durbin and Mr. A. Stuart: "Non-Response and Clustering in Sample Surveys: an Experimental Study".

Thursday, May 20

ROYAL AERONAUTICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Dr. A. R. Russell: "The Choice of Power Units for Civil Aeroplanes" (42nd Wilbur Wright Memorial Lecture).

Friday, May 21

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Dr. R. S. Oliver: "Visual Aids to Bad-Weather Approach".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. A. C. B. Lovell: "Britain's Giant Radio Telescope".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SENIOR SCIENTIFIC OFFICER (with a university degree of high standard or equivalent qualifications in appropriate field, and with several years relevant research experience) in the Department of Supply, Defence Standards Laboratories, Maribyrnong, Victoria, Australia, for research into the development and application of techniques of optical instrument technology, photometry and colorimetry—The Senior Representative (A.P.13), Department of Supply, Australia House, The Strand, London, W.O.2 (May 20).

ASSISTANT LECTURER, LECTURER or SENIOR LECTURER IN ORGANIC CHEMISTRY at the University College of Khartoum—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.O.1 (May 21).

HEAD (with a higher degree, recent experience in research, teaching experience in a university or technical college, and/or industrial experience) of THE DEPARTMENT OF METALLURGY, County Technical College, Wednesbury—The Director of Education, Department F.S., County Education Office, Stafford (May 22).

TECHNICIAN (preferably with some experience in photography and/or microtechnique) in THE DEPARTMENT OF BIOLOGY—The Registrar, University College of Swansea, Singleton Park, Swansea (May 22).

CHAIR OF APPLIED METEOROLOGY—The Secretary and Registrar, University College of North Wales, Bangor, N. Wales (May 24).

LECTURER (with special qualifications in palaeontology) in GEOLOGY—The Secretary, University of Durham, 28 North Bailey, Durham (May 24).

SENIOR AGRICULTURAL ECONOMIST and an AGRICULTURAL ECONOMIST (with a degree in economics or agriculture, and with research experience in economics or agricultural economics)—The Secretary, School of Agriculture, The University, Cambridge (May 25).

ASSISTANT LECTURER IN PURE MATHEMATICS and an ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, King's College, Strand, London, W.O.2 (May 28).

ASSISTANT LECTURER, Grade III, or LECTURER, Grade II (preferably with a special knowledge in vertebrate palaeontology or palaeobotany) in THE DEPARTMENT OF GEOLOGY—The Registrar and Secretary, The University, Bristol (May 29).

ASSISTANT LECTURER in GEOLOGY—The Registrar, University College of South Wales and Glamorgan, Cathays Park, Cardiff (May 29).

SENIOR LECTURER in SOCIAL STUDIES, a SENIOR LECTURER in CHEMICAL ENGINEERING, a LECTURER in MATHEMATICS, and a LECTURER in TEXTILE SCIENCE—The Principal, Royal Technical College, Peel Park, Belfast 5 (May 29).

ASSISTANT LECTURER or LECTURER (with special qualifications in inorganic chemistry) in THE DEPARTMENT OF CHEMISTRY—The Registrar, University College of Wales, Aberystwyth (May 30).

LECTURER in GEOLOGY with special reference to Stratigraphy—The Secretary, Queen's University, Belfast (May 30).

ASSISTANT LECTURER (preferably with an interest in Western Europe and/or climatology) in GEOGRAPHY—The Secretary, University College London, Gower Street, London, W.O.1 (May 31).

LECTURER (graduate in agriculture and specialised in poultry) in POULTRY, at Gwehi Agricultural College, Southern Rhodesia—The Secretary, Rhodesia House, 420 Strand, London, W.C.2 (May 31).

LECTURER (with university teaching qualifications and experience) in STATISTICS or STATISTICAL MATHEMATICS, at the University, Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.O.1 (Hong Kong, May 31).

MINES AGENS FELLOW (with Ph.D. degree or its equivalent in chemistry or biochemistry) in RADIOPHYSICS, in the Department of Chemical Pathology, to carry out original work on steroid hormones—The Secretary, King's College Hospital Medical School, Denmark Hill, London, S.E.5 (May 31).

PLANT BREEDER (science graduate with aptitude for research, and preferably with postgraduate training and experience in plant breeding, statistics, field experimentation and soil science) in THE FIELD HUSBANDRY BRANCH, Department of Research and Specialist Services, Southern Rhodesia Government—The Secretary, Rhodesia House, 420 Strand, London, W.C.2 (May 31).

ASSISTANTS in THEORETICAL OR EXPERIMENTAL PHYSICS in the Department of Natural Philosophy—The Secretary, The University, Aberdeen (June 1).

DEMONSTRATOR (with a good honours degree in physiology, biochemistry or chemistry with subsidiary physiology) in CHEMICAL PHYSIOLOGY—The Registrar, The University, Manchester (June 1).

RESEARCH ASSISTANT in MATHEMATICAL STATISTICS and a RESEARCH ASSISTANT in NUMERICAL ANALYSIS in the Department of Applied Mathematics—The Registrar, The University, Liverpool (June 1).

CHIEF OF RESEARCH AND DEVELOPMENT, LEADER OF CHEMISTRY SECTION, LEADER OF METALLURGY SECTION, LEADER OF ENGINEERING AND CHEMICAL ENGINEERING SECTIONS, and a SENIOR MATHEMATICAL PHYSICIST, with the Australian Atomic Energy Commission, Sydney—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Alfred House, Kingsway, London, W.O.2 (Sydney, June 5).

LECTURER (with a good honours degree and practical experience, and preferably with research experience) in CIVIL ENGINEERING—The Registrar, The University, Nottingham (June 5).

LECTURERS (2) in GEOLOGY (General and Economic)—The Secretary, The University, Edinburgh (June 5).

ASSISTANT LECTURER in CHEMISTRY at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.O.1 (June 8).

ASSISTANT AGRICULTURAL ECONOMIST (graduate in economics and/or agriculture)—The Registrar, The University, Bristol 8 (June 12).

LECTURER in THE DEPARTMENT OF BIOCHEMISTRY—The Secretary, The University, Edinburgh (June 15).

RESEARCH FELLOW (with an honours degree in chemistry or agricultural chemistry, and experience in the chemistry of soils) in SOIL CHEMISTRY, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.O.1 (June 20).

LECTURER in CROP PRODUCTION (Plant Breeding), a LECTURER in ANIMAL PRODUCTION, a LECTURER in ANIMAL HEALTH, and a LECTURER in AGRICULTURAL ENGINEERING, at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.O.1 (June 20).

RESEARCH STUDENTS (with the degree of Bachelor or Master of a British University, other than Manchester) in SCIENCE—The Registrar, The University, Manchester (July 1).

SENIOR LECTURER in METALLURGY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.O.1 (New Zealand, July 1).

SENIOR LECTURER IN PHYSICS at Rhodes University, Grahamstown, South Africa—The Secretary, Association of Universities of the British Commonwealth, 6 Gordon Square, London, W.C.1 (South Africa, July 1).

ASSISTANT LECTURER, Grade B, IN THE DEPARTMENT OF CHEMISTRY, College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff.

ASSISTANT (medically qualified, and preferably with experience in bacteriology) in the BACTERIOLOGY DEPARTMENT—The Secretary, University College Hospital Medical School, University Street, London, W.C.1.

ENGINEER (Basic grade) to assist in the design and development of mechanical equipment, such as laboratory instruments and light and medium mechanical engineering devices and prototypes to scientists' and Service requirements—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 58/W.G.B.2.

ENGINEER (with first- or second-class honours degree or equivalent in mechanical or aeronautical engineering, and with practical experience), at the Royal Aircraft Establishment, Farnborough, Hants, for work in the Armament Division on research and development of air armaments and their installation in aircraft—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting 0.903/54A.

LECTURER IN MATHEMATICS and a **LECTURER IN PHYSICS** at the Higher Teachers' Training College, Baghdad—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7.

LECTURER (with previous university teaching experience, and preferably with an interest in physiology and ecology) in Botany—The Principal, Sir John Cass College, Jewry Street, London, E.C.3.

PHYSICIST (with first- or second-class honours degree in physics, and a bias towards physical chemistry and physics of solids), at the Royal Aircraft Establishment, Farnborough, to work with the Electrical Engineering Department on investigations concerning physics of solids, particularly with regard to formation of oxide and graphite films on metals by rubbing action of graphite brushes, and study of factors influencing oxidation of petrol and oils, and consequent fire risk with electrical equipment so contaminated—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.119/54A.

PLANT PATHOLOGIST or PLANT PHYSIOLOGIST (with a degree in natural science and training in plant pathology or plant physiology, and preferably with experience in coffee diseases) in Kenya, to investigate diseases of coffee, at the Coffee Research Station, Bura—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting O.D.R.03/7015.

RESEARCH ASSISTANT (honours graduate, with zoology or physiology as principal subject, and preferably with a knowledge of physics and/or postgraduate laboratory experience) in the RADIOLOGY LABORATORIES—The Administrative Officer, Christie Hospital and Holt Radium Institute, Manchester 20.

SENIOR EXPERIMENTAL OFFICER (with H.S.C. (science) or equivalent qualification) to act as Chief Programmer for an electronic digital computer, and to advise on the best methods of proposing problems for the machine—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 133/W.G.B.2.

SENIOR LECTURER IN PHARMACOLOGY and a **SENIOR LECTURER IN PHARMACEUTICS**—The Registrar, College of Technology and Commerce, The Newark, Leicester.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Road Research Technical Paper No. 28: The Rheology of Non-Aqueous Suspensions. By P. J. Bagden. Pp. vi+50+2 plates. (London: H.M. Stationery Office, 1954.) 2s. 6d. net.

Building Research Station Digest No. 63 (February, 1954): Questions and Answers. Pp. 4. (London: H.M. Stationery Office, 1954.) 2d. net.

Department of Scientific and Industrial Research. Road Research Laboratory. Index of Publications of the Road Research Laboratory January 1953-June 1953 (Revised). Pp. iv+42. (London: H.M. Stationery Office, 1954.) 1s. 6d. net.

Macaulay Institute for Soil Research. Annual Report 1952-1953. Pp. 56+2 plates. (Craigiebuckler, Aberdeen: Macaulay Institute for Soil Research, 1954.)

Corrosion Prevention and Control: Engineering—Equipment—Technology. Vol. 1, No. 1, March, 1954. Pp. 64. (London: Corrosion Prevention and Control, 140, Cromwell Road, B.W.7, 1954.)

Proceedings of the Royal Irish Academy. Vol. 56, Section A, No. 1: On the Transfer of Energy Between Electromagnetic Dipoles. By J. L. Synge. Pp. 12. 2s. Vol. 56, Section A, No. 2: Electric Charge and Current Generated by Combined Maxwell-Einstein Fields. By H. Schroedinger. Pp. 12-62. 1s. 6d. Vol. 56, Section A, No. 3: The Instability of the Tippe-Top Explained by Sliding Friction. By Stephen O'Brien and J. L. Synge. Pp. 23-36. 2s. Vol. 56, Section B, No. 1: Salmon Movements Around Ireland—4. By Arthur H. J. Went and F. A. Gibson. Pp. 12. 2s. Vol. 56, Section B, No. 2: Salmon Movements Around Ireland—5. By Arthur H. J. Went and Kenneth U. Vickroy. Pp. 18-23+1 plate. 2s. 6d. Title Page and Index to Vol. 55, Section A: Mathematical, Astronomical, and Physical Science. Pp. 4. Title Page and Index to Vol. 55, Section B: Biological, Geological, and Chemical Science. Pp. 8. (Dublin: Hodges, Figgis and Co., Ltd., 1953 and 1954.)

Other Countries

Register of Current Scientific Research at South African Universities, 1953. Pp. vi+212. (Pretoria: Council for Scientific and Industrial Research: Library and Information Division, 1953.)

West African Institute for Oil Palm Research. Quarterly Progress Report, No. 7. (October 1, 1953, to December 31, 1953.) Pp. 17. (Benin City: West African Institute for Oil Palm Research, 1954.)

The Carlsberg Foundation's Oceanographical Expedition Round the World 1928-30, and Previous "Dana" Expeditions under the Leadership of the Late Professor Johannes Schmidt. Dana Report No. 88: The Genus *Isanthus*: a Monograph. By Dan Laursen. Pp. 40+1 plate. 10 Danish kroner. 10s. Dana Report No. 40: Paraleptidae I (Paraleptidae and Leptidae): Taxonomy, Ontogeny, Phylogeny and Distribution. By Vilh. Ege. Pp. 184. 40 Danish kroner; 40s. (Copenhagen: Andr. Fred Hest & Son, 1953.)

Bakterien unter Hemmstoffwirkung. Elektronenmikroskopischer Bildatlas. By Dozent Dr. G. Reimann. Pp. 16+Tafel 1-101. (Berlin-Wilmersdorf: Transmare-Photo G.m.b.H., 1954.)

Annals of the New York Academy of Sciences. Vol. 57, Art. 8: Parental Age and Characteristics of the Offspring. By Leonal O. Strong and 21 other Authors. Pp. 451-614. (New York: New York Academy of Sciences, 1954.)

Sudan Government: Ministry of Agriculture. Bulletin No. 9: Agriculture, Forests and Soils of the Jur Ironstone Country of the Bahri M. Ghassal Province, Sudan. By W. M. F. Byre, D. M. Ramsey and T. H. Jewitt. Pp. 40. (Khartoum: Ministry of Agriculture, 1953.) P.T. 20.

British Guiana. Geological Survey of the Diamond and Gold Deposits of the Makuru District, Ouyuni River, British Guiana (An Explanation of Sheet No. D2 (Makuru, 1953)). Compiled by H. B. Pollard. (Bulldin No. 24.) Pp. 11+28. (Georgetown: Geological Survey, 1953.) 1 dollar. 4s. 2d.

Osservatorio Astronomico di Milano-Merate. Supplementi Meteorologici No. 8: Prime Misure Sulla Radioattività delle Precipitazioni Atmosferiche. Da L. Santomauro e A. Ganga. Pp. 11+8. (Milano: Ulrico Hoepli, 1954.)

National Geographical Society of India. Bulletin No. 20: Presidential Address delivered to the Geology and Geography Section of the 41st Session of the Indian Science Congress, Hyderabad-Deccan, 1954. Part 1: The Drainage Patterns observed in India and the Adjacent Countries. Part 2: The Development of Landforms in the Himalayas. By Dr. H. L. Ohlsson. Pp. 34+9 plates. (Banars: National Geographical Society of India, 1953.)

Aligarh Muslim University Publications. (Zoological Series.) On Indian Insect Types—Edited by M. B. Mirza. 3: The Skeleto-muscular Mechanism of *Stenocranus decessus* Cameron (*Brachydes, Hymenoptera*)—An Metoparasite of Sugarcane and Juar Borer of India. Part 2: Abdomen and Internal Anatomy. By S. Mashood. Pp. 11+76+7 plates. (Aligarh: Aligarh Muslim University, 1953.) 8 rupees, 8 annas.

Research Bulletin of the East Punjab University. No. 31 (Zoology): Spermatogenesis in the Dragon-Fly *Synsphyron hypocyrtus* (Selys). By Vishwar Nath and Rajinder Bahl. Pp. 67-72+2 plates. No. 32 (Zoology): The Louse Sperm. By G. P. Sharma and A. P. Malik. Pp. 73-91+3 plates. 2 rupees, 2 annas. No. 33 (Chemistry): Potentiometric Studies in Oxidation-Reduction Reactions, Part 18: Oxidation with Alkaline Potassium Permanganate. By Balwant Singh, Awar Singh and M. S. Raj Kumar Nahan. Pp. 93-106. 1 rupee, 14 annas. No. 34 (Chemistry): Osmototropic Reactions with Ethylenic Carbonyl Compounds. 1: Convenient Syntheses of some Methoxy Naphthalene Derivatives. By O. P. Vlg. N. K. Maheshwary and S. M. Mukherji. Pp. 107-115. 1 rupee, 2 annas. No. 35 (Zoology): Studies on the Protozoa of Indian Fishes. 1: The Morphology and the Systematic Position of the Ciliates Inhabiting the Intestine of Fish *Mystus ocellatus* (Hamilton). By Manohar Singh. Pp. 117-128+6 plates. 3 rupees, 4 annas. No. 36 (Chemistry): Thiopagan Derivatives. Part 2. By M. S. Dhali and K. S. Narang. Pp. 129-144. 1 rupee. (Jhalapur: East Punjab University, 1953.)

Sudan Government: Ministry of Agriculture. Annual Report of the Research Division, 1950/51. Pp. 11+188. (Khartoum: Ministry of Agriculture, 1953.)

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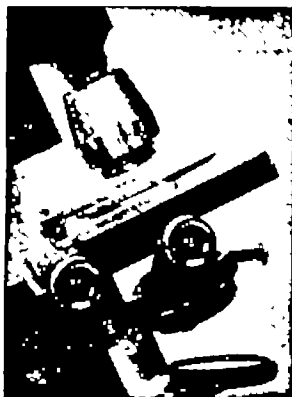
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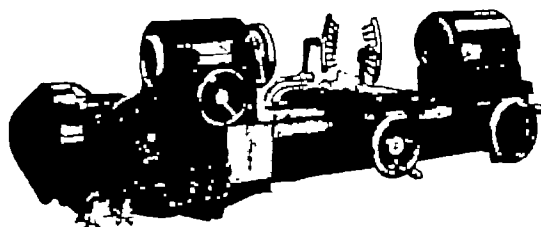
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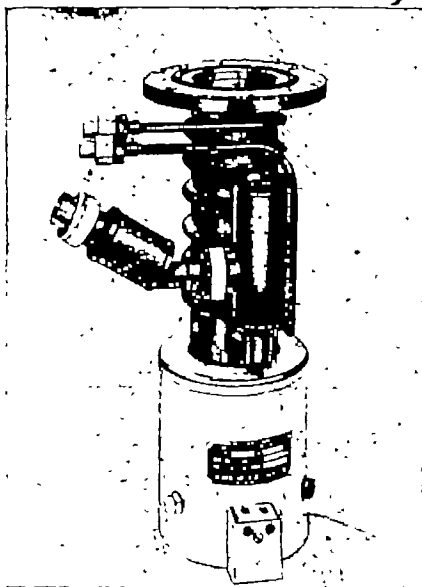
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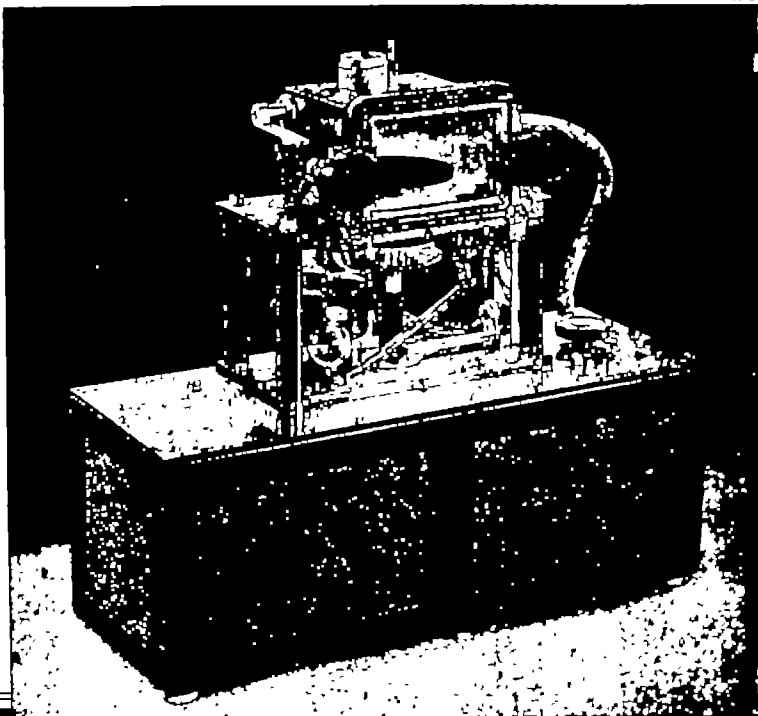
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EDUCATIONAL TASKS IN BRITAIN

IT is now generally appreciated that the shortage of trained man-power in Britain is the basis of the shortage of school-teachers—and particularly teachers of science—about which there has been much discussion in recent months. In the House of Commons on April 27 the matter was debated and some suggestions offered (see *Nature*, June 12, p. 1105); but clearly the fundamental thing is further support for education. This may well involve sacrifices in other parts of the social services, and before this could be contemplated, an informed public opinion prepared to give to education its proper place in the national life is essential. The creation of such a public opinion is itself, in the view of Mr. Eric James, High Master of Manchester Grammar School, perhaps the greatest of our educational tasks and the basis for all other reforms—the supply of teachers, an adequate building programme for schools and for technical colleges, the reform of the content of education, and administration of educational policy. Only if it learns to give to education its true importance, urges Mr. James, can democracy prosper, either materially or spiritually.

The two *Planning* broadsheets on "Schools under Pressure" and the debate in Parliament, like discussions at educational conferences earlier this year, show how far we are yet from this position, and how much remains to be done to secure the formulation of an adequate policy at all levels of education, let alone the allocation of resources sufficient to implement it. The supply of science teachers is only one facet of the problem, though it well illustrates the hopelessness of the situation if care is not taken to align policy with what is practicable rather than what is theoretically desirable. It is, as Mr. James notes, the most immediately dangerous aspect of the wider problem of the absolute shortage of natural ability, particularly in scientific fields, caused by the increasing demands which our civilization makes for high ability.

Whether the failure to recognize this is wilful or not, the consequence will be the same: as Mr. James put it, in the conditions of modern life the rule is absolute; the race which does not value trained intelligence is doomed. It will matter little what other excellences our educational institutions possess if they fail to recognize and foster high ability, wherever it is found, as well as to meet the demands which democracy makes on the wisdom, integrity and sense of responsibility of ordinary people. Perhaps the most disturbing features of the present situation are that so many influences are tending to weaken whatever contribution our educational system has hitherto been able to make towards the development of such wisdom, integrity or sense of responsibility, and that this tendency is encouraged by certain features of party politics.

We can scarcely expect, therefore, that either political party will formulate an adequate educational policy and implement it with resources which are in

keeping with what is required on a realistic view of national needs without a good deal of pressure from independent organizations and individuals as well as from those who do not allow a particular party allegiance to inhibit such a realistic view. Incidentally, a welcome feature of Dr. W. Idris Jones's presidential address, "Energy for Britain—the Decades Ahead", to the Institute of Fuel on April 8, was the clarity with which he emphasized the dependence of the developments he forecast in fuel economy, the reduction in atmospheric pollution and increase in efficiency of fuel-burning, on more training and the diffusion of adequate technical and scientific knowledge, as well as on adequate research and development. More people, from directors and managers downwards, must become more conversant with the efficient use of fuel and energy. Whether the challenge which the next half-century will present to men of foresight, courage, adaptability and creativeness is met depends largely on the adequacy of our policy for education, general as well as technical and technological.

Nevertheless, the Parliamentary Secretary to the Ministry of Education, replying on May 11 in an adjournment debate on technical education, particularly in Sunderland, once again revealed the limitations of the Government in this respect. New buildings and extensions to existing buildings for technical education are now being approved, he claimed, at the rate of about £4.5 million a year, while between January 1, 1948, and February 1954 projects valued at £11.5 million had been completed. In February 1954, projects for more than £17 million were under construction but not yet completed, while projects amounting to £6.5 million in the 1953–54 and 1954–55 programmes had been approved but not yet started.

Nowhere did he give a hint that the Government has a policy for technical education, and that this has been thought out in regard to the needs of technological education and the resources available; it is not clear how the selection was made of the twenty-three technical colleges which he said had been authorized, to run the courses receiving 75 per cent instead of 60 per cent grants from the Ministry.

Clearly the need is for an all-party approach, able to eliminate local or sectional prejudice and pressures, and facilitate the acceptance of sacrifices on non-essentials as well as to improvise short-term remedial measures and to formulate and execute a long-term policy. Besides clear thinking, there must be an end to the present policy of drift, which is hindering the development of technological and technical education, no less than that of primary and secondary education. Scientists who understand the way in which the existing deficiencies in technical colleges and in technological education affect industrial development and efficiency, and the repercussions which the shortage of science teachers can have on the supply of scientists for our research institutions and universities as well as for industry and the Departments of State, will not imagine that the problem can be dealt with in isolation. Dr. Idris Jones has set an example to be followed by others

as opportunity offers. The full support of men of science should be given to those who urge on the Government the imperative need of immediate and concerted action, both to increase the supply of science teachers in particular and to alleviate the over-crowding of classes and the defects in school buildings and technical colleges on which the Select Committee on Estimates has commented so forcefully.

A CHEMIST'S CONTRIBUTION TO COSMOLOGY

The Planets

Their Origin and Development. By Harold C. Urey. (Yale University: Mrs. Hespera Ely Silliman Memorial Lectures.) Pp. xvii+245. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1952.) 30s. net.

THE origin and development of the solar system has always been, and seems likely to be for a long time, an outstandingly difficult subject. It has been written about it, often in happy ignorance of the complexity of the problem; the accumulation of relevant observational data in modern times has increased rather than lessened the formidable task of the cosmologist.

Earlier theories were largely concerned with dynamical arguments, including gravitation, and these remain as a control to any new theory. To bring modern spectroscopic observations of the sun and planets into line with the data involves extensive incursions into the domains of physics, chemistry and geology, and into areas where, at best, the data are fragmentary and where, at worst, the 'system' available for study, up to the present, is not reproducible at will, and must be inferred most part by formulae that depend on data derived from laboratory data. Thus, the system of thought that has so successfully resolved many of the problems of physics is applicable only with severe limitations; each writer therefore tends to propose a new scheme, with *ad hoc* hypotheses to cover some of the phenomena that do not fall naturally into place.

Some twenty or thirty years ago it was generally recognized that the difficulty was not so much to discriminate among hypotheses as to find one single theory that fitted all the observations. More recently there has been a spate of new theories, often characterized by boldness of imagination. The vast developments in physics and chemistry make it difficult to find investigators with the imagination, breadth of knowledge and mathematical technique to make the grand synthesis. To master even the current literature requires, in addition, great energy and enthusiasm. It is no exaggeration to say that the author of this book, Prof. H. C. Urey, is one of the few men of science possessing such an array of talents.

Prof. Urey, as one of the world's leading chemists, is apologetic at his entry into cosmology: but he has no need to apologize, for many of the arguments depend on the laws of physical chemistry, with less extrapolation than is often the case with physical laws. His enthusiasm is bubbling over right through the book, and, indeed, it is for this reason that the

treatise makes rather slow reading, for to the agile mind of the author a pedestrian elaboration of his definitions and arguments must seem a little irksome; and it is perhaps better so, for in cosmological discussion one cannot expound along a single track—the simile of a network is more appropriate. At the end (Chapter 7) Prof. Urey summarizes his scheme and conclusions; in some ways it would have been much more helpful to the reader to put this chapter at the beginning as a guide. As it is, one does not easily gather from a direct reading of the book what is the author's plan of presentation. Prof. Urey has obviously taken great pains to marshal all the relevant material and to do full justice to the views of others, and this, particularly on the physical chemical side, makes his book a valuable work of reference. There are some misprints that no doubt will be corrected in a future edition.

Roughly speaking, Urey postulates a 'cold origin' for the planets as distinct from the 'hot origin' of the older theories. The development proceeds from a solar dust cloud, consisting of gas and dust, from which, by contraction, the central temperature rose until the carbon cycle continued the development of the central portion as a star. The outer disk-like part broke up into large masses, which (presumably) constituted what the author calls "preprotoplanets" and "early protoplanets"; what is to be understood by these terms is not made at all clear, but in Table 19 they are indicated as consisting of gas, dust and planetesimals. Now what is meant by "planetesimals" is not easy to grasp: the word trickles in unobtrusively on p. 27 ("the surface [of the moon] was thoroughly cold when these planetesimals fell"), and on p. 31 there is mention of "the theory that the planets accumulated from particles originally of small size", but presumably these bodies are not to be identified with the planetesimals of Chamberlin and Moulton. Some planetesimals appear to be like iron or stony meteorites and may perhaps be of the size of small minor planets, but in a future edition (and one may certainly hope that the author will continue to develop the ideas so refreshingly set out in this book) no doubt a more precise indication will be given.

The next stage is the onset of condensation, at temperatures comparable with those existing now at corresponding distances from the sun, of the preprotoplanets. The chemical state of the elements and compounds present is inferred from the ordinary laws of chemical equilibrium. An important mechanism of aggregation is the coagulating effect of condensed vapours such as water and ammonia. This stage is invoked in order to account for the retention of some of the volatile constituents, such as water and nitrogen, which for the most part escape into space. Adiabatic compression of the gas now raises the temperature to something of the order of 2,000° K., and during this hot stage, involving volatilization of some of the silicates, small bodies evaporate, iron-nickel alloy is formed in the larger bodies, and the largest bodies form this alloy in their outer parts while maintaining cool interiors. This chaotic state is, of course, difficult to follow through in detail, but during the contraction the insulating effect of the gas is held to be important, so that at the end of this stage the iron-nickel phase (arising from reduction of iron oxides) will not in all the planets have formed a core. Following this contraction, the cooling gives rise to a further low-temperature stage of consolidation, with the continued

escape of gases from the outer parts, until a final stage is reached in which the planets have assumed something like their present constitution. It is, of course, impracticable even to outline here the supposed life-histories of the planets separately.

One distinctive feature, however, of the later stage of the evolution of the earth must be cited. The author rediscusses the secular accelerations of the sun and moon following the treatment by Jeffreys, except that a possible change in the moment of inertia of the earth is allowed for. The consequences are interesting: the moment of inertia is shown to decrease with time, causing a decrease in the length of the day of the order found by Brouwer. This is held to result from the progressive flow of iron from the mantle to the core; just how this flow is compatible with the constitution of the mantle is by no means clear, but if it is assumed that vertical channels are formed, it is considered that iron may separate out from the silicate phase of the mantle and coalesce into drops which could penetrate as a liquid through these channels. This separation has not taken place in Mars and the moon, and the author suggests that the formation of a core may help to provide the energy for the formation of mountains. At present one can say so little about the viscosity and perhaps the microstructure of the interior of the earth that one ought to welcome this new hypothesis (which is presented quantitatively so far as the data allow) in the hope that it may stimulate further researches.

Prof. Urey's chemical training gives a freshening aspect to his review of dynamical and thermodynamical theories, and it is of especial value in discussions of the origin and composition of meteorites and of comets. He inclines to Whipple's 1950 theory of the formation of comets; unfortunately, Lyttleton's dynamical work has been published too recently to receive notice from Prof. Urey. One continues to marvel, indeed, that the author can have found so much time and energy to delve deeply into both early and recent writings on so many topics, and one is left with the impression that present-day cosmology is somewhat like the earlier stages of the solar system before its members settled down to their present orderly arrangement. It may be predicted that ultimately the ordered knowledge of our system will owe a debt to Prof. Urey's criticism and imagination.

R. STONELEY

PLANT-GEOGRAPHY ANCIENT AND MODERN

The Geography of the Flowering Plants

By Prof. Ronald Good. Second edition. Pp. xiv + 452 + 25 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1953.) 50s. net.

THAT the plant-covering of the world varies greatly from region to region, each having its peculiar or especially abundant plants, came vividly to the notice of the ancient Greeks in the fourth century B.C. when Alexander's armies occupied Egypt, crossed Persia and Afghanistan and entered the Indian subcontinent. In these eastern lands they met a diversity of vegetational types previously unknown, and they were quick to associate them with differences of climate and soil. Displaying an acuteness which commands respect even now, they recog-

nized generic resemblance and specific divergence between plants of different regions. Of this the Indian banyan (*Ficus benghalensis*) supplies a remarkable example. Notwithstanding its aerial roots and unusual habit of growth, its entire leaves and small fruit, the Greeks classed it as a kind of fig ($\sigma\upsilon\chi\eta$). Although they found an ivy (*Hedera nepalensis*) on a mountain of the western Himalaya (a find of special interest since ivy could not be made to grow in Babylon despite persistent attempts to naturalize it there), Alexander's men noted that scarcely a tree or shrub or herbaceous plant of India agreed with those of their native Hellas.

Observations such as these form the basic material of plant-geography. Theophrastus (b. 370 B.C.), who recorded and correlated so many of them, may accordingly be honoured as the founder of descriptive phytogeography; but not until the nineteenth century did it develop into an important scientific study. In the third quarter of that century its leaders were Alphonse de Candolle of Geneva and Sir Joseph Hooker of Kew, and in the last quarter the Germans Grisebach, Engler, Drude and A. F. Schimper. Since the publication of their works, further exploration and collecting, and study in the fields of taxonomy, ecology, floristics and cytology, have assembled so much extra information relevant to plant-geography that new surveys are urgently required but have become more and more difficult to prepare. Three major works in recent years have attempted to provide introductions and guides to this bewildering accumulation of facts and hypotheses, namely, S. A. Cain's "Foundations of Plant Geography" (1944), R. D'O. Good's "The Geography of the Flowering Plants" (1947 and 1953) and L. Croizat's "Manual of Phytogeography" (1952). None makes the others redundant. Of these, Good's book, which has now reached a second edition, is primarily a survey of the distribution of systematic plant-groups throughout the world to-day and of the factors controlling this distribution. It is the only modern text-book in English which makes such a global survey.

In general, the new edition (1953) of "The Geography of the Flowering Plants" agrees with the earlier edition (1947). It is, however, fifty pages longer. Comparison of the two editions page by page reveals minor and major changes throughout, these ranging from slight emendations of wording and the correction of errors to lengthy new passages which incorporate new material or give additional emphasis. This revision, covering illustrations and maps as well as text, has added much to its value. Especially worthy of note is the re-drafted classification of the world into floristic regions and the new map illustrating this. Inevitably in a work of such wide scope there are minor matters which have escaped emendation, the following being a few examples. The name Trapaceae (p. 63) has precedence over Hydrocaryaceae. The family Tropaeolaceae (p. 64), credited with thirty species, probably comprises about sixty-five species. *Davidia* (p. 120) is not a Himalayan but a Chinese genus. Sources of information on *Rhododendron* (p. 152) later and more comprehensive than those cited are the *Rhododendron* Society's "Species of *Rhododendron*" (1930) and papers by Cowan and Davidian in the Royal Horticultural Society's "Rhododendron Year Book". The name *Tofieldia palustris* (p. 166) should be corrected to *T. pusilla*, as pointed out in *J. Linn. Soc., Bot.*, 53, 194-204 (1947), where maps of distribution will be

found. Happily, *Delonix regia* (p. 213) still grows wild in a limited area of Madagascar.

The book concludes with a bibliography increased to 629 entries as against 295 in the first edition. Its value would be much greater had the author inserted page references. The extent and importance of a paper are rarely evident from its title alone; page references indicate to the experienced whether it is likely to be worth while making a journey to consult a work, contriving to borrow it or having a transcript or photostat made, for in no one library will the reader find available all the works cited here; hence, the omission of page references gives the bibliography an unfinished slipshod appearance out of keeping with the care bestowed upon the rest of the book. Among papers meriting inclusion are: R. Pampanini, "Essai sur la géographie botanique des Alpes" (*Mém. Soc. Fribourg Sci. Nat. Géol. Geogr.*, 3, fasc. 1; 215 pages; 159 distributional maps; 1903); A. Eig, "Les éléments et les groupes phytogéographiques auxiliaires dans la flore palestinienne" (*Fedde, Repert. Sp. Nov., Bot.*, 63, 201+120 pages; 1931), whence come the terms "Irano-Turanian", "Saharo-Sindian" and "Sudan-Deccan" used by writers on the flora of the Near East; and Hui-Lin Li, "The Phytogeographic divisions of China" (*Proc. Acad. Nat. Sci. Philadelphia*, 46, 249-277; 1944). Backer's work on Krakatau, cited as "n.d.", was published late in 1929. Strangely enough, the author fails to date precisely his own papers on *Empetrum* (actually 1927) and *Cremanthodium* (actually 1929). These blemishes detract little, however, from the worth of the book as a whole, which is well written and brings together much information not readily available elsewhere. All who use the first edition for teaching purposes would do well to acquire this enlarged and amended new edition. Those unacquainted with the book at all will find it a sound introduction to a vast and interesting field of study.

W. T. STEARN

CALCULUS OF VARIATIONS

Calculus of Variations by Parallel Displacement
By Prof. W. S. Kimball. Pp. viii+543. (London: Butterworths Scientific Publications, Ltd., 1952.) 50s. net.

IN a series of papers published in the *Philosophical Magazine* since 1937, Prof. W. S. Kimball has put forward new basic conditions in the calculus of variations. Their distinctive feature is that they are obtained by differentiation of a line integral. It is claimed that this method, which does not use what is generally called the fundamental lemma of the calculus of variations, has several advantages, and its application gives two new working-rules for the solution of examples. The book under review starts with an account of these new methods and combines them with the classical methods of Euler, Lagrange, Jacobi, Hilbert, Weierstrass and others to form a comprehensive treatise on the subject.

The preface and introduction emphasize that in this book all the principal expressions, both new and old, are obtained as rates of change. This is shown, in considerable detail, in Chapters 1-3. Chapters 4 and 5 show how to apply the basic equations to problems. Chapter 6 gives a very thorough account of the application to dynamics, especially to the theorems of Hamilton and Jacobi. The next chapter

returns to the general theory, and deals systematically with Hilbert integrals, which have already been mentioned from time to time in the preceding work, and with the criteria for maxima and minima due to Legendre and Weierstrass. This leads on to Chapter 8, which contains the envelope theorem and Jacobi's necessary condition. The author returns to applications in Chapters 9 and 10, which deal with the brachistochrone and Newton's problem concerning the form of a projectile which offers minimal resistance to the air. Newton's problem offers a surprising difficulty, for its solution has a discontinuity in slope, and this is used to introduce the theory of corner conditions. The next two chapters deal with this theory in detail by the methods of Weierstrass and Erdmann. Chapter 13 is devoted to minimal surfaces of revolution, and Chapter 14 to a further development of Hilbert integrals. The book concludes with an elaborate index. A very short bibliography occurs on p. 10. There are numerous problems, mostly with answers, at the ends of the chapters.

The degree of difficulty of the book appears to be somewhat variable. The discussion of the basic theoretical ideas, especially those originating with the author, appears to assume more mathematical maturity than the discussion of applications, but disclaims "the extremely exacting modern standards of mathematical rigour". The emphasis is on geometry and mechanics rather than on the finer points of mathematical analysis, "without contention that the complete story is told, although it is intended to be included by implication". H. T. H. PIAGGIO

PARASITES OF THE COD

Parasites Animaux de la Morue Atlanto-Arctique.
(*Gadus callarias* L. (= *Morhua* L.))

Par Robert Ph. Dollfus. Pp. 428. (Encyclopédie biologique, Vol. 43.) (Paris: Paul Lechevalier, 1953.) 5,000 francs.

INDEBTED as they already are to Dr. R. P. Dollfus for his considerable contributions to parasitology, all who are interested in parasites, and especially those who are interested in the parasites of fishes, will find this volume a useful addition to their libraries. Explaining that the book is a summary of notes he has made on the subject, Dr. Dollfus remarks that he is not certain that the account he gives of the parasites of the cod is complete, because he has not been able to consult all the literature on this subject, Russian publications having been excluded, and because species of parasites not yet found in the cod may be recorded from this fish in the future. He suggests that he may have cited species which have been incorrectly identified, and explains that he has not been in a position to make sure of the identity of all of the species named.

The volume is, nevertheless, a useful one. It describes about ten species of Protozoa, three species of leeches, two species of monogenetic and about sixteen species of digenetic trematodes, nine species of cestodes, ten or eleven species of nematodes, seven species of Acanthocephala and fourteen species of parasitic Crustacea. Some of the species described are found in the cod wherever this fish occurs; others are found in it only in certain of its habitats; but much remains to be learnt about many of them. The author says that about sixty-nine species have been described as being parasitic in the cod, but that

many of these are doubtful and that probably none of them is specific to the cod. This host always harbours several species at the same time. None of the species recorded from it can be transmitted to man, but one species, namely, the trematode, *Cryptocotyle lingua*, the larval, metacercarial phase of which is encysted in the skin of the cod, can be transmitted to the dog and cat. The adult trematode of this species also occurs in the fox, and it was recently found for the first time in Britain in an otter killed in the suburbs of Edinburgh by Mahfouz A. M. Fahmy (personal communication to the reviewer).

The book, which is issued in paper without boards, is well produced, and its illustrations, all of which are in line, are a valuable feature of it. The bibliography, which the author warns us may not be complete, occupies forty-one pages of small type.

G. LAPAGE

A CONCISE REVIEW OF ANTIBIOTICS

Antibiotics

By F. A. Robinson. Pp. viii+132. (London: Sir Isaac Pitman and Sons, Ltd., 1953.) 15s. net.

IN the field of study of antibiotics, numerous monographs and text-books have been written and the field has become too wide for comprehensive study. The author of this book is to be congratulated in presenting in concise and readable form a broad survey of antibiotics. It should prove invaluable to students and will help the non-specialist in the field to get up to date with general aspects, especially where a chemical bias is desired.

The subject of sulphonamides as an introduction to the book would appear to be unnecessary. The antibiotics in major production are described fully with respect to their production, extraction, spectrum, resistance, pharmacology, mode of action, chemistry and assay; and the lesser-known antibiotics grouped together as mould antibiotics, antibiotics from Actinomyces, and bacterial antibiotics. Such a system allows of easy reference, which, however, might have been improved by bibliographic references in the text. In reviewing the production, extraction and chemistry of the antibiotics, the author has reached a very high standard of presentation. Unfortunately, this standard is not maintained in the pharmacological portions, where some apparently contradictory statements are made: for example, the inhibitory action of penicillin on Gram-negative coliforms is referred to on p. 30, whereas the table of organisms inhibited shows no Gram-negative coliforms; also, streptomycin is used in undulant fever but ineffective in brucellosis. Generalized statements on toxicity rather than lists of LD₅₀'s would make easier reading and not detract from the value of the book.

The author approaches, but does not quite achieve, a consistent system of bacterial nomenclature. Formulae of culture media, excretion statistics and dosage-levels would benefit by tabular or graphical presentation. The details of biological assays have, wisely, been left to the specialized monographs on the subject.

The book can be strongly recommended to degree students and should also prove interesting reading to the general scientist.

A. M. COOK

Population Problems

By Warren S. Thompson. With the assistance of Evangelyn D. Minnis. Fourth edition. (McGraw-Hill Series in Sociology and Anthropology.) Pp. xiii+488. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 52s.

DEMOGRAPHY as a subject of study tends to be neglected in British universities, and it is therefore a tribute to the author that "Population Problems" has now reached its fourth edition since 1930. The general plan of the book remains much the same, yet the author has found it possible not only to include post-war data (much of it up to 1950) but also to incorporate many of the findings of demographic research during the decennium since the publication of the previous edition.

The book is probably best described as a sound introductory text for non-mathematical students. After a rapid survey of population theories from Malthus to Carr-Saunders, the author discusses in turn the determinants of the size of a population—births, deaths and migration. Up to the end of the eighteenth century it was the death-rate which kept in check the growth of population. In modern Western civilization the check is provided by voluntary family limitation. This remarkable transition from uncontrolled mortality to controlled fertility—from the ravages of plague and famine to the planning of parenthood—is discussed widely if not deeply. There are useful chapters on the composition of a population as disclosed by a census, on the decline in the birth-rate, and on class differences in natality and mortality.

The author's attempt to relate factors from medicine, public health, geography, history, economics, psychology and sociology in order to explain the observed facts of demography takes him over too wide a field for thorough discussion of any one topic, while his avoidance of anything that could be called mathematical robs the text of some precision that could have been attained. The last point, however, comes perilously close to criticizing a book which the author never intended to write. H. SILOOCK

Journal of the Institute of Metals

Edited by N. B. Vaughan. Vol. 78, 1950-51. Pp. xxiv+772+80 plates. Vol. 79, 1951. Pp. xxvii+514+61 plates. (London: Institute of Metals, 1951.)

THE Institute of Metals continues to publish papers on a wide range of subjects, and these two volumes of its *Journal*, covering the years 1950-51 and 1951, respectively, contain much work of interest. Vol. 78 contains twenty-one papers, together with a symposium on metallurgical aspects of the cold working of metals, and the Autumn Lecture on communications metallurgy by E. E. Schumacher. Vol. 79 contains the presidential address by Prof. A. J. Murphy, the May Lecture on science in the service of the community by Sir John Anderson (now Lord Waverley), together with twenty-three papers. In the two volumes, the universities, the British Non-Ferrous Metals Research Association and industrial scientists each contribute ten or twelve papers. Six papers are from Australia and serve to emphasize the growth of metallurgical research in this member of the British Commonwealth. Only five papers are published by United Kingdom government laboratories, and the shortage of papers from these sources is to be regretted and may prejudice the recruitment of staff. While many

branches of metallurgy are included, some, such as crystal structure determinations of alloy phases, are absent from these and from the preceding two volumes, and it would be in the interests of metallurgical science if some of this work were attracted to the *Journal*. The two volumes are attractively produced, but the cloth cover of Vol. 78 is too weak for its size. W. HUMPHREY

Lecture Notes on the Use of the Microscope

By R. Barer. Pp. vii+76. (Oxford: Blackwell Scientific Publications, Ltd., 1953.) 6s. net.

THIS little book can be given a whole-hearted recommendation. It is written by one who has made the microscope one of his principal instruments for research, and understands it thoroughly. Essentially practical in treatment, these notes have, however, been written with an eye on modern theoretical work, and they could be read with advantage not only by beginners but also by many others who have occasion to use microscopy in the course of their work.

The author deals mainly with the straightforward operations in visual work and does not enter into the more complicated aspects such as phase-contrast, ultra-violet microscopy, and so on; nor does he deal with photomicrography, though indeed many readers will wish that an introductory chapter on this topic could have been included. A useful section answers a number of the questions which often puzzle the beginner, though it is to be feared that many tantalizing queries will always arise to perplex even the most expert.

The preface asks: "Would it be too much to ask that one afternoon . . . should be spent in learning to understand an instrument which the student may continue to use for the rest of his life . . . ?" Surely the question inadvertently implies a very great reward for two or three hours of concentration. One might perhaps learn to obtain a passable image, but its proper interpretation is quite another matter.

L. C. MARTIN

Wood Chemistry

Second edition. Edited by Louis E. Wise and Edwin C. Jahn. Vol. 1. (American Chemical Society, Monograph Series No. 97.) Pp. vii+688+xxiii. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1952.) 120s. net.

WOOD is still the most widespread industrial material used in the world. It is a source of many of the world's synthetic fibres, of most of its paper and board, and of a large proportion of its fuel. Its constituents and by-products are used in industries as wide apart as the manufacture of solvents and tanning-agents. Moreover, all these industries are based essentially on the chemistry of wood. This indicates the background of the work under review, the first volume of which now published deals with the growth, anatomy and physical properties of wood, its cell wall and extraneous constituents, its surface properties, and its chemical utilization, biological decomposition and chemical analysis.

The two editors are recognized authorities on the subject in the United States, and they are assisted by twenty-two collaborating specialist authors, mostly American, although the chapter on biological decomposition is by the late W. G. Campbell, of the Forest Products Research Laboratory, Princes Risborough. Although the book is largely academic in character,

there is throughout a close correlation between the results of research and their technological applications. The team has, in fact, done its work very well indeed and has produced a comprehensive and up-to-date volume which all interested in the pure and applied chemistry of wood will wish to possess. Unfortunately the high price may prevent a number of them doing so.

JULIUS GRANT

Methods of Statistical Analysis

By Cyril H. Goulden. (Wiley Publications in Statistics.) Second edition. Pp. vii+467. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 60s. net.

THE first edition of this book was published in 1939. This second edition is almost a new book. After three introductory chapters, it deals with analysis of variance, regression and analysis of covariance. It then proceeds to experimental designs and, in particular, to incomplete block and factorial experiments. There follow chapters on non-orthogonal data, goodness of fit, the discriminant function and probit analysis. A final chapter on quality control has been added, but it seems rather out of key with the rest of the work.

Any scientific worker, whatever his field, who wishes to know the nature and scope of the subject, can scarcely do better than begin with this book by C. H. Goulden. Deriving his inspiration from the work of R. A. Fisher, the author runs very lightly over what J. B. S. Haldane once called anti-hallucination statistics: he arrives at the analysis of variance in Chapter 4 without having discussed standard errors in large sample theory. Some preliminary reading might therefore be recommended to the beginner before he embarks on the book; but once it has been carried out, he can be safely entrusted to Dr. Goulden's concise and careful treatment. This is quite one of the best introductions to modern statistical methods in experimentation that has yet appeared.

M. G. KENDALL

Atomic Transmutation

The Greatest Discovery ever Made; from Memoirs of Prof. Frederick Soddy. By Muriel Howorth. Pp. 134+4 plates. (London: New World Publications, 1953.) 12s. 6d.

IN order to explain the phenomena of radioactivity, Rutherford and Soddy, working together at McGill University, put forward fifty years ago the theory that the atoms of a radioactive substance undergo a process of disintegration which gives rise to the formation of a new atom distinct in physical and chemical properties from its parent. This natural transmutation of the radioactive elements is hailed by the author of this book as "the greatest discovery ever made by man in the history of time". It is her contention, and most of us would agree with her, that the outstanding developments which followed from that initial discovery must be made known to all, both men of science and laymen. However, we may not all agree with the methods she adopts and advocates.

Miss Muriel Howorth is the founder of the Institute of Atomic Information for the Layman, and at the Institute's meeting held on February 28, 1953, the jubilee of Rutherford and Soddy's discovery, Prof. Soddy was invited to talk about those days, "Just fifty years ago". The text of his address, together with the opening proceedings of the meeting, form part of the volume under review. Prof. Soddy

describes in no modest vein the series of events and experiments in which he participated, during the early part of the century. As a kind of introduction to the speaker, Miss Howorth has written these memoirs of Prof. Soddy in which she manages, in the course of what can best be described as a newspaper interview by an over-admiring reporter, to recount mainly in Prof. Soddy's own words his early life and his experimental work up to 1904.

Practical Chromatography

By R. O. Brimley and F. C. Barrett. Pp. 128. (London: Chapman and Hall, Ltd., 1953.) 15s. net.

IN view of the recent spate of books on chromatography, any new book, in order to have any value, must either present an up-to-date review of research on this subject or else must deal with it in such a way that any newcomer to the field should be able to adopt the technique directly to his own problem. In view of this, any short monograph on the subject, such as this one by R. O. Brimley and F. C. Barrett, is of doubtful value. No part of the subject is dealt with at sufficient length, and in addition the proof-reading has been such as to allow a number of glaring mistakes to creep in. For example, a separation showing peaks labelled ammonia, mono-, tri- and di-methylamines is described as showing the separation of fatty acids.

The field of chromatography is now so vast that the main need is for detailed monographs or frequently published critical reviews, and books such as this one fall into neither category.

A. T. JAMES

Woodland Ecology

By Ernest Neal. (The Scholarship Series in Biology.) Pp. xii+107. (London: William Heinemann, Ltd., 1953.) 6s.

THIS is an admirable little book for teachers of biology and for sixth-form students in schools, for whom it is primarily intended. Mr. Ernest Neal has written with the definite aim of helping the student to find out for himself the general pattern of woodland ecology and has achieved something intensely practical that must appeal to keen naturalists of any age.

Limitations of space set a difficult task in dealing adequately with a habitat so complex and so varied, but the task has been successfully tackled by taking the first-hand study of a particular woodland and pointing the way from this. Throughout there is emphasis on integration of details, and the reader is left with an overall picture of the wholeness of the woodland community.

The earlier chapters are concerned with plant ecology, providing the necessary foundation for a proper understanding of the animals and their food relationships. Practical advice is given on methods of finding and collecting animals and on equipment for studying microclimates. The discussion of various types of food chain has much to guide the reader in the fascinating work of tracking down these inter-relationships. The remainder of the book is largely devoted to a consideration of different kinds of adaptations of behaviour and structure which are of value to animals in their competition for food, self-preservation, reproduction and dispersal. There are several good photographs; also included are an appendix giving concrete suggestions for the study of woodland ecology in schools, and a short bibliography.

MAURICE ASHBY

INTERNATIONAL FLAME RADIATION RESEARCH COMMITTEE

NEW LABORATORY

ON April 28, at the Royal Dutch Blast Furnace and Steel Works at IJmuiden, Holland, the laboratory containing the new experimental furnaces of the International Flame Radiation Research Committee was inaugurated. This organization is supported by industry and nationalized industries in Great Britain, France, Holland, Sweden, Belgium and the United States of America, on a basis of free co-operation, in which the various countries contribute not only in funds but also in the loan of engineers and scientists to carry out trials, and of materials and instruments. Until the present time, the main experimental work has been done at IJmuiden on an old furnace not designed specially for the purpose and which was nearing the end of its useful life. The new furnaces just installed have been designed and built specially for studying the radiation and combustion properties of furnace flames, using instruments developed for the purpose. The work will continue to be supplemented by studies on small-scale furnaces in the various countries, but the necessity for near full-scale work has been strongly stressed and the object of the new furnaces is to fill this need.

There are two furnaces, one for oil and gas fuels and the other for pulverized coal, but as yet only the former is operating. The building housing the furnaces includes an instrument room which gives a central and open view of the two furnaces, a specially equipped gas-analysis room, and two auxiliary rooms for pumps, power distribution, stores, etc. Outside

the building there are three liquid-fuel storage tanks. It is intended to provide as soon as possible a combustion air preheater in order to study the effects of raising the entry temperature of the air. Coal preparation plant for the pulverized fuel trials will also be provided in the course of the present year. The experimental station is easily accessible by road and has its own railway siding. The total cost of the completed installation and its services, including all auxiliary equipment, will amount to approximately £60,000.

Furnace for Oil and Gas Firing

Figs. 1 and 2 show side views of this furnace, which has an inner cross-section of 2 m. $\times$ 2 m. and a length of 6.3 m. Since it is intended to work at temperatures up to 1,600°C., sillimanite has been chosen as the refractory material. The complete wall is constructed of one brick of sillimanite, a half-brick of porous sillimanite acting as a high-quality insulating brick, and a half-brick of ordinary insulating brick.

Roof and bottom are of the same composite character as the walls. The whole furnace except the roof is within a light steel casing. Whereas the old furnace rested on the ground, which meant that constant conditions could be obtained only after a week or longer, the new furnace is built clear of the ground, and rests on a set of beams. This may also facilitate measurement of the heat losses through the

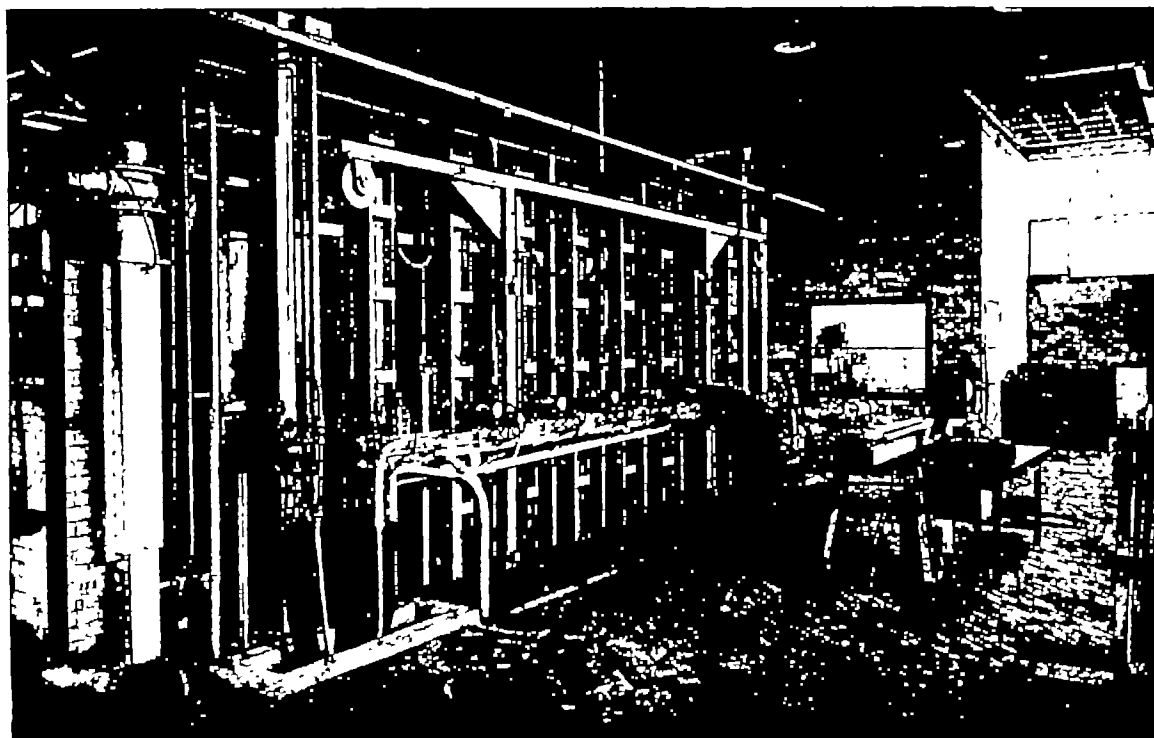


Fig. 1. View of the experimental furnace showing vertical slots for radiation measurements



Fig. 2. View of the experimental furnace showing the doors for probe instruments

bottom. Along the sides of the furnaces are eight vertical slots through which measurements of radiation, etc., can be made (Fig. 1).

Special consideration has been given to the construction of the doors closing the openings, in view of the large number of slots and holes in the walls, in order to minimize air in-leakage. The east wall is used for radiation measurements only, the west wall being designed for the insertion, at fixed and known positions, of the various kinds of probe for exploring temperatures, gas composition, soot density, etc. (Fig. 2).

A horizontal beam has been designed on which all the pyrometers can be mounted with their supplies of water and clean air and wiring, the beam being raised up and down by means of two long-screwed spindles mechanically coupled. The water-cooled doors have been made to slide along a pair of water-cooled tubes, one on each side of the slot. In this way, the holes in the doors are always in line with the radiation pyrometers on the beam, and at the same time, reasonable air-tightness has been achieved. On the west wall fixed doors have been provided to cover the slots.

In order to get the maximum results from the measurements, all input variables are under automatic control. Oil can be taken from three different tanks, and preheated as required. Steam (after being superheated in a small gas-fired unit), compressed air, coke-oven gas and oxygen can be taken from the works mains, measured by orifices, and controlled to give a constant flow. Propane, if required, can be taken from a railway tank-car, reduced in pressure and sent to the furnace after being measured.

The combustion air is delivered by fans. When the air-preheater has been installed, air at any temperature up to 750° C. can be supplied.

The average load of the furnace will be roughly 2.5×10^6 kcal. hr.⁻¹, that is, approximately 250 kgm. of oil or 600 m.³ coke-oven gas per hour.

Furnace for Pulverized-Coal Firing

This furnace has been designed along the same lines as the oil and gas furnace, although it has a smaller cross-section (1.5 m. $\times$ 1.5 m.) and is much longer (10 m.), the ratio of length to cross-section being about 7:1 as compared with 3.5:1 for the gas and oil furnace.

The furnace will be constructed with a wall thickness of one and a half bricks, consisting of one brick of high-quality insulation (hot-face) with a special coating against ash attack, backed by a half-brick of ordinary-quality insulation brick. It will be equipped with the same arrangement of slots, doors, moving beam, etc., as the oil and gas furnace.

The floor is to be inclined towards one side, and small doors provided on this side in order to facilitate ash removal.

The average load of the furnace will be of the order of 250 kgm. coal per hour; by means of water-cooled pipes to be introduced through holes in the roof, the thermal load of the furnace can easily be varied between 20 and 70 per cent.

It is also planned to equip this furnace with oil-burning facilities, in order to be able to compare the different types of fuel under exactly the same conditions.

The purpose of the coal preparation plant is to provide the furnace with dry pulverized fuel of widely different characteristics. It must therefore have maximum flexibility, and the separate operations of crushing, drying, milling and weighing are interconnected through storage hoppers. The maximum capacity of the plant will be 500 kgm. coal per hour.

The coal, having been crushed to a size of 3 mm., will be dried in a pneumatic dryer and then pulverized to 90 per cent minus 200 mesh in a ball mill and stored in a 2-ton hopper, whence it will be weighed and deposited at a constant rate into the primary air dust. It is planned to burn coals ranging from anthracite to lignite or brown coal and from 8 to 30 per cent ash content.

Experimental Facilities

These can be divided into different groups. The first group consists of six electronic recorders and one indicator which are of the universal type, with interchangeable ranges and chart-speeds. Some are line recorders, other multipoint recorders. They record all the electrical outputs which are obtained with the furnaces, from radiation and suction pyrometers, thermocouples in walls and roof, heat-flow meters, etc. All leads from both furnaces end in a panel from which any recorder can be connected, by means of flexible leads, with any measuring source.

The second group of facilities, that for gas analysis, is housed in a separate room near the furnace stacks; the equipment in this small laboratory is similar to that of a normal gas-analysis laboratory. Two gas-analysis recorders for carbon dioxide allow rapid surveys to be made of flow patterns in the furnace, or they can be used for recording the carbon dioxide content of the waste gas. There is also a modified Bone and Wheeler gas-analysis apparatus for accurate determination of gas components, special provision being made for the sampling and analysis of carbon soot in the flame. Both the instrument room and the gas-analysis room are kept under a slight air-pressure to minimize the penetration of dust.

The third group consists of instruments set up in a room in the Central Laboratories. These instruments comprise two black-body radiation furnaces, with potentiometers for calibration of radiation pyrometers; thermocouples and heat-flow meters, and further equipment for analysis of gas and carbon soot samples (including an analytical balance). Finally, it should be mentioned that a small water-cooled furnace, which has been in operation for several years in the Research Laboratories of the Royal Dutch Steel Co. at Delft, has been transferred recently to this station. This furnace is a geometrically correct model of the oil- and gas-fired furnace, and has been and will continue to be used for testing scale effects on flame radiation under conditions which can be changed more widely and rapidly than is possible with the full-size furnace. This model furnace will be erected in a few weeks in the pump room, and use will be made of all the facilities for control and experimenting which are already available.

Broadly speaking, two kinds of trials will be carried out on the furnaces. The first, termed performance trials, will measure the overall performance of the furnaces for different conditions including burners, fuels, atomizing agents, inlet temperatures, etc., and it is expected that this will give results leading to immediate improvements in industrial furnace design. The second type of trial, known as combustion mechanism trials, will consist of systematic exploration throughout the furnace of temperatures, gas combustion, soot deposits, etc., with the aim of providing a basis for a theory of flame combustion and radiation.

O. A. SAUNDERS

THE STUDY OF FAST CHEMICAL REACTIONS

FARADAY SOCIETY DISCUSSION AT BIRMINGHAM

ALTHOUGH the word 'fast' is a relative term, the chemist has a fairly clear idea of what he means by a fast reaction: it is one which occurs in a time that is short compared with the times required for ordinary chemical manipulation. Such changes are as numerous and as varied in type as the slower reactions but have one feature in common—that special experimental techniques are required for their investigation. These techniques were the subject of the Faraday Society Discussion held in the Chemistry Department of the University of Birmingham during April 7–9. The president of the Society, Prof. R. G. W. Norrish, was in the chair, and the meeting was attended by 230 people, about thirty of whom were from overseas. Introductory papers to the two sections on gas- and liquid-phase reactions, respectively, were given by Prof. H. W. Melville and Mr. R. P. Bell. There were contributions from physicists, chemists and biologists, and a valuable feature of the Discussion was that it brought to wider notice a number of techniques which, though potentially of general application, have been developed and used almost exclusively for one field of study. The diversity of methods described was no less than the variety of fast reactions to which they have been applied. The half-times of these reactions cover the range from several seconds to 10^{-11} sec., and nearly every conceivable physical property was considered as a means of following such a change.

When the half-time of reaction is less than a few seconds, two difficulties arise in its experimental investigation: first, it is necessary to initiate the change in a time which is short compared with the time of reaction, and secondly, a means of following the reaction must be found which is of sufficient sensitivity and which has a short response-time. Alternatively, instead of measuring a parameter directly as a function of time, the rate of the rapid reaction may be arrived at by introducing the time parameter in the form of a competitive process such as diffusion or another reaction of known rate. The latter method has been most widely used and was represented by a number of contributions to this Discussion, but there was a sign that the direct methods of approach are being more widely applied than in the past.

An obvious way of initiating a reaction is by mixing, and when this method is used the time of mixing is the limiting factor which determines the fastest reaction that can be studied. It has been mainly applied to liquid systems and is suitable for reactions with half-times greater than about 1 msec. The original continuous flow method, developed by Hartridge and Roughton thirty years ago, which has been of such great utility in the study of biological systems (F. J. W. Roughton), has now taken a variety of forms. The two liquids may be injected from separate containers into the mixing vessel and then studied by photoelectric (K. Dalkiel) or thermal (L. Pearson, B. R. W. Pinson and F. J. W. Roughton) methods as they flow along an observation tube at a known rate. In the stopped-flow technique the reactants can be made to impinge on a light piston which suddenly arrests the flow (Gibson). Such

apparatuses have been made semi-automatic and can be accurately controlled by thermostat (E. F. Caldin and F. W. Trowse), and by using regenerative flow (B. Chance and V. Legallais) the performance may be increased by ten- to a hundred-fold without the expenditure of additional solution. Chance has given detailed consideration to the design criterion for optimum performance of flow systems. Rapid quenching, which is frequently a useful technique in slower reactions, can also be applied to fast reactions in flow systems (B. R. W. Pinnent). A third modification is the capacity flow method (K. G. Denbigh and F. M. Page) where the well-mixed reactants are allowed to reach a steady state in a vessel. This is unsuitable for half-times less than about one second, but covers a time range where the continuous flow methods are less convenient. A related method is the use of the thermal maximum attained in an exothermic reaction which is losing heat to the surroundings at a known rate (R. P. Bell, V. Gold, J. Hilton and M. H. Rand). It does not involve a steady state, but measurement is made during a momentary stationary condition which is easy to observe. The method of mixing of reactants may also be applied to gas reactions, though it becomes difficult to study half-lives shorter than 0.1 sec., not only because of the rate of mixing but also because the requirement of constant temperature becomes increasingly disturbed by the heat liberated from the reaction (H. S. Johnston). This is less serious in liquid systems owing to the greater thermal capacity.

Photochemical initiation has been widely used in the study of fast reactions, the rate of the fast reaction usually being obtained by a steady-state treatment, involving another process of known rate. A new type of steady-state measurement, in a gaseous photochemical system, is to observe the temperature rise, which may be of the order of 0.1 deg. C., by means of a fine platinum wire placed a known distance from a plane window to which it is losing heat (A. B. Callear and J. C. Robb). It has the advantage that a rate measurement can be made in about one second, so that very little reaction has taken place. Photochemical methods may also be used to initiate a reaction for subsequent study by direct methods. In order to obtain an observable change, flash photolysis is used, and by this means the intermediate free radicals may be prepared in a fraction of a millisecond at a concentration high enough for spectroscopic observation (R. G. W. Norrish and G. Porter). The method has now been applied to reactions in solution, in particular to the detection and study of the triplet states of molecules which are found to have half-lives between 10^{-8} sec. and 10^{-9} sec. in fluid solvents (G. Porter and M. W. Windsor). Here we have a new type of fast reaction, which is of very general occurrence and which exhibits many unusual features.

Another common method of initiating a reaction is to raise the temperature of the reactants. When this is done by admitting the mixture to a heated vessel, about one second elapses before a uniform temperature is attained, and the method is not therefore applicable, in this form, to fast reactions. The temperature of a gas may be raised by as much as 1,000 deg. C. in a very short time, however, by the use of a shock wave. A diaphragm, separating a gas at high pressure from the reaction mixture at a lower pressure, is broken, and after passage of the shock front the reaction is followed photoelectrically with a time resolution of about 5 μ sec. (D. Britton, N.

Davidson and G. Schott). Here one is measuring the relaxation time which elapses before the system adjusts itself to the new equilibrium conditions, and a variety of other techniques, applicable to the study of very fast reactions, operate on the same principle. The gas may be made to flow slowly and isentropically through a nozzle and then be rapidly compressed, in a few microseconds, in front of an obstacle. The observed difference between original pressure and stagnation pressure is then directly proportional to the entropy gained in the latter compression (S. H. Bauer and M. R. Gustavson). Relaxation techniques may also be used for the study of ionic reactions in solution where the half-times may be less than 10^{-9} sec. A disturbance of the electrolytic dissociation equilibrium may be effected, by rapid variation of pressure (sound absorption), electrical field density or temperature, and the change may be introduced periodically by a single impulse or in the form of a rectangular step. All these cases are accessible to mathematical treatment (M. Eigen). The relaxation of the second Wien effect in the presence of radio-frequency fields may be used by measuring power loss, or apparent ohmic resistance, at various frequencies (R. G. Pearson).

An unconventional method of initiating reaction is by mechanical activation of one of the reactants. This may be brought about by a rapidly rotating blade, the molecules being flung from the tip of the blade with a velocity equivalent to an energy of 10 kcal./mole (T. H. Bull and P. B. Moon). The method requires further development but has interesting possibilities.

Apart from the method of initiation, the principal problem of fast reaction studies is to find a suitable means of following the change. The main difficulties here are twofold: when the response time of a detector is increased, its sensitivity is automatically decreased; secondly, fast reactions are always accompanied by temperature changes, and indeed in the most rapid changes the process occurs virtually adiabatically. It is therefore essential to use a physical quantity which is relatively insensitive to temperature, and these are not numerous. By far the most useful is light absorption, which can be conveniently followed by photoelectric methods or by flash spectroscopy. A second approach, which has been used by a number of authors, is to measure the temperature rise itself. Several methods of doing this have already been mentioned, and a further example is the measurement of the temperature profile in the reaction zone when one reactant is introduced to the other through a jet (D. Garvin, V. P. Guinn and G. B. Kistiakowsky). This is a generalization of the 'highly dilute flame' technique of Polanyi and is applicable to reactions other than those which show resonance absorption or emission, or give solid deposits.

Dielectric constant and refractive index are very dependent on temperature, but may nevertheless be used as sensitive methods of following rapid chemical change. It is usually found that the temperature effect is the greater, and correction is made for the effect due to chemical change. By interferometry, which can be carried out rapidly using photoelectric techniques, temperature changes of 2×10^{-4} deg. C. can be followed (G. M. Burnett, P. J. Deas and H. W. Melville). Nuclear magnetic resonance spectroscopy is a method which has not hitherto been applied to fast reactions and which appears promising. The details of the resonance spectrum

are strongly modified when the nucleus in question is suffering a sufficiently rapid change in chemical environment (R. A. Ogg).

Conductimetric methods, using high-frequency oscillators, are useful for following ionizable systems in solution. At megacycle frequencies it is not necessary to have electrodes in contact with the solution and more rapid recording is possible (P. J. Elving). Changes in ion concentration during a fast reaction can be measured by using a rotating platinum-wire electrode in conjunction with an automatic recording polarograph (I. M. Kolthoff and W. L. Reynolds). One of the oldest electrochemical methods, which has seldom been applied, is 'voltammetry at constant current' (P. Delahay). It has certain advantages over polarography, but both methods are limited by the difficulties of theoretical analysis of reactions of higher order than the first.

The older methods of chemical kinetics, where the velocities of very fast reactions are inferred from a leisurely analysis of the final products, will continue to play an important part, especially as new tools, such as isotope-enriched molecules, become available (R. A. Ogg and W. T. Sutphen). With this wealth of experimental method the often-encountered statement that a reaction was 'too fast to follow' should disappear from the literature. The only danger appears to be the one mentioned by Prof. Melville in his introductory remarks, that one may become so impressed by the gadgetry that one loses sight of the purpose for which the gadget was designed. The final criterion by which any experimental technique must eventually be judged is the originality and reliability of the information which it provides.

GEORGE PORTER

MARINE BIOLOGY IN NATAL

By ROBERT CLARKE

National Institute of Oceanography, Wormley, Surrey

LIKE many other countries since the Second World War, South Africa now faces the problem of nourishing a rapidly increasing population. Although she has vast tablelands, their fertility is menaced by a widespread soil erosion, and it is natural that South Africa should turn for her protein supplies more and more to the resources of the sea. On her west coast the cold, productive Benguela Current maintains extensive fisheries for pilchard, hake and snook, and to the south is the flatfish ground of the Agulhas Bank. The demands of research and development in these areas may be expected, in the future as in past years, to preoccupy the attention of the Division of Fisheries, Cape Town, whose research ships have already done valuable work on the west and south coasts. On the other hand, the resources of the east coast remain practically unknown: the seas between Mozambique and East London, except for certain excellent studies of the littoral fauna, have scarcely been explored by fishery biologists or oceanographers. It is therefore most encouraging to learn that this neglect is shortly to be remedied by the building of a new and extensive marine research station at Durban in the province of Natal. Funds for the project are being subscribed by the recently founded South African Association for Marine Biological Research*.

* "South African Association for Marine Biological Research" (Central Press, Durban, 1953).

What purely faunistic surprises may await the investigator are suggested by the discovery of the first ctenophore off East London in 1938 and, in the past year or two, of other specimens in the Mozambique Channel. Apart from the ctenophore, however, the diversity and fascination of the problems awaiting solution in this region, contrasted with the scant attention it has received, greatly impressed me during the voyage of the Royal Research Ship *William Scoresby* in 1950 when, in the midst of a whale-marking cruise, the ship conducted a limited amount of oceanographical work and experimental fishing across the Mozambique Channel and in the Agulhas Current opposite East London. Because the area is extensive, the work of other expeditions, though valuable, has been no less incomplete. The R.R.S. *Discovery II* has worked some oceanographical stations up the Mozambique Channel and in the Agulhas Current off Durban, including a few extending eastward into the West Indian Ocean. On the coast banks some experimental trawling has been done by the *Africana* from the south towards Durban. The abyssal fauna of the oceanic region remained unexplored until 1951 when the *Galathea*, by several successful hauls in latitudes around Durban and in the Madagascar Deep, indicated the scope for work of this kind. These fragmentary investigations are no more than pointers for an oceanographical survey, complete in its widest sense, which the waters east of Africa deserve and which offer a fund of problems to the South African Association for Marine Biological Research.

A great deal has yet to be learned about the hydrology of the south-east African region. To the south of Madagascar the Mozambique Current is augmented by another arm of the Trade Wind Drift and flows southward, following the line of the African coast, as the warm, swift Agulhas Current. Between the main current and the coast there is a minor stream of cold water, of variable extent and velocity, which sets to the northward. So far as I am aware, nobody has yet investigated the origins of this counter-current, or its effects on the organic productivity of the coastal area. Hydrological survey of the counter-current may also suggest means of controlling the banks of shifting sand which are caused by this current and which at present are a major problem to the engineers of Durban harbour. One of the most interesting yet least understood things about the main Agulhas Current is the likely presence of marginal upwelling. This phenomenon is something quite distinct from the counter-current and is believed to occur when the main current is accelerated, as by strong winds, so that the denser water (which in the southern hemisphere always flows on the right-hand side of a current system) is brought to the surface on the inshore side of the current by hydrodynamic forces. Such marginal upwelling of nutrient-rich cold water, adjacent to or over a coast bank, may be sufficient to increase the productivity of waters available for fishing.

The most obvious biological effect of the Agulhas Current is the environmental one regarding the physical and chemical parameters it establishes for the fauna, including the economically important fish fauna. Temperature is most important. The current in the Mozambique Channel has a warm-water fauna of Indo-Pacific character. As the current moves southward it becomes cooler, approaching the region of the West Wind Drift off the extreme south coast of Africa. So it happens that the sea off the coast

of Natal is a region of transition where Indo-Pacific forms mingle with elements of the temperate Cape fauna. All authorities are agreed that the Natal area is very rich in species, and as a transitional region it is specially attractive to the taxonomist and ecologist and to the scientist interested in problems of evolution. Prof. J. L. B. Smith has studied intensively, though he would not wish to say exhaustively, the littoral fishes of Natal, and Prof. T. A. Stephenson and his colleagues have examined the ecology of the littoral invertebrates; but less attention has so far been paid to transitional problems in the neritic and oceanic faunas which include the actual or potential species of major economic importance. Thus the Cape hake sometimes extends to the Natal region and, especially in winter, may even appear in great shoals. Practically nothing is at present known of this seasonal invasion. The Cape snoek (*Thyrsites*) does not penetrate into Natal waters, where the local 'snoek' is a species of *Scomberomorus*; but the possibility of exploiting *Scomberomorus* on a large scale might be investigated.

Among the oceanic fishes of the current, the giant scomberoids, like the tunny, may be sufficiently abundant to allow a regular fishery. The tunny at the present time is everywhere becoming increasingly popular as a food fish. A survey of the myriad shoals of flying fish would not only be important in regard to the distribution and possible migrations of the tunny and albacore which prey on them, but also would be important in itself, for flying fish are excellent eating and in California and Barbados they are fished on a commercial scale.

Any wide survey may discover new fishing banks. The search far afield need not be disregarded. Off the south coast of Madagascar lies the Star Bank, where I have myself hauled the trawl and been impressed by the wealth of fauna: the Star Bank certainly deserves a fishing survey. On the coast banks of Natal itself there is an abundance of sharks. The shark fishery which once existed at Durban might be revived if attention could be given to such problems as extracting the liver oil, refrigerating, salting and packaging the meat, preparing meat meal, shark leather and shagreen, and marketing these products.

Technical problems of this kind would doubtless be included in the scope of the new station. Its aquarium also (which will be a major feature of the building) could be used not only for purely biological studies but also for such technical investigations as the development of electric fishing methods.

There may be several potential inshore fisheries awaiting the results of survey and research. In South Africa eels are only found in rivers flowing east to the Indian Ocean, and the story of their spawning migration has still to be told. Pearl oysters occur in the Natal area and there are possibilities for oyster-farming on a commercial scale. Some extremely interesting surveys by Prof. J. H. Day and his colleagues have indicated the abundance of prawns and fish in certain estuaries on the Natal coast. There may be opportunities here for farming of a kind which has been very successful in many parts of Asia. Furthermore, the abundant pensid prawns (which in Natal take the place of the Cape crawfish) are thought to be migratory, and the tracing of these migrations may lead to an offshore prawn fishery like that discovered in deep water by the late Prof. Johan Hjort and made into a considerable industry in Norwegian seas.

Although territorial problems may need to be settled, an oceanographical survey which includes the Madagascar seas might find the search for guano worth while: it is possible that on such islands as Europa Island there are exploitable deposits of seabird guano.

Whaling is conducted from the Bluff at Durban, so the new marine station may expect to have excellent opportunities for research on whales and the special problems of the whaling industry. Here is a field for investigations of great economic importance, for Durban takes mostly humpback and sperm whales, the life-histories of which are still imperfectly known. Apart from two seasons work by the former Discovery Committee's staff in 1926 and 1930, and some whale marking by the *William Scoresby* in 1950, there seems to have been no research on these stocks in their migrations along the waters east of Africa.

By establishing the new marine station in a sub-tropical area, the South African Marine Biological Association reflects that interest in the possible resources of warm seas which since the Second World War has led to the setting up of research centres on several tropical seaboard of the British Commonwealth and the Colonies. These are government institutions, but it seems that most of the funds for the Durban Station are being raised from the subscriptions of private citizens. We wish the Association well.

PURIFIED CASEIN FOR NUTRITIONAL RESEARCH

By ALICE M. COPPING

Queen Elizabeth College, University of London

NUTRITIONAL experiments for the past thirty years have progressively emphasized the need for a source of protein which is pure and of high biological value, and it has come to be realized that casein is the most suitable protein for experiments with such small animals as rats, mice and chicks and such large animals as pigs. Latterly, it has been used also in experiments with insects and in microbiological studies. Casein is the principal but not the only protein providing the food of the growing calf, and its high biological value has been demonstrated by Karl Thomas¹, by McCollum², by Chick and co-workers³ and by many others using various techniques. It contains all the essential amino-acids though the relative amount of the sulphur amino-acids is rather low, so that experimental diets are more certain to be satisfactory when they contain about 20 per cent of casein than if they have less than 10 per cent. The low content of sulphur amino-acids has to be remembered in choosing the methods for purifying casein, care being needed to avoid damage to them.

By 1920, when Coward⁴ reported the occurrence of a growth factor, different from the then recognized vitamins, in light white casein it was known that purification by washing and extraction was essential to give a casein that could be used satisfactorily in diets for studying vitamin A and the B vitamins. At this point it is relevant to give some description of the types of casein products available for biological studies. Light white casein, to which reference is made above, is not a true casein but a caseinate

formed by treatment of casein with dilute alkali, as sodium hydroxide or calcium hydroxide. High-grade caseins for animal diets are generally acid caseins and not caseins produced by rennin precipitation. The acid caseins may be prepared by natural lactic acid precipitation produced by bacterial action in sour milk or by the addition of hydrochloric or other acids. Acid caseins contain some lipid substances which can be removed by alcohol extraction in order to decrease the content of fat-soluble vitamins. The alcohol extraction process removes only part of the vitamin B complex, and further washing with sodium chloride solution to remove riboflavin and with acetic acid for other B vitamins is necessary to give a 'vitamin-free' product. It is now known that these processes should be undertaken during manufacture preferably before the curd has been dried. In the final processing and drying, careful attention to temperature and other conditions is required to give a product that is substantially free of all vitamins and that, at the same time, retains its high biological value.

Before purified caseins became commercially available, research workers purified their own caseins. At the Lister Institute a casein suitable for diets free from vitamin A was for many years prepared by heating light white casein with constant aeration obtained by frequent raking of the material in shallow trays in an electric oven at 110° C. The heated casein was satisfactory for vitamin A studies, but not for work with the vitamin B complex. For the latter purpose the caseinate was subjected in the laboratory to precipitation by dilute acetic acid, followed by washing and extraction with 70 per cent alcohol¹. The process was very laborious, and preparation of solvent-extracted casein was soon taken over by commercial suppliers, and extracted caseins could then be purchased. From 1930, commercial developments in Great Britain and in the United States provided purified caseins of various grades for research laboratories. The most satisfactory products were obtained by precipitation of casein at its isoelectric point with subsequent extraction and washing. Unless all processes were fully controlled, the physical properties of the products might vary and the caseins became difficult to incorporate into diets and media. As identification of the various members of the vitamin B complex progressed, it seemed probable that solvent extraction denatured the product in some way which affected the growth of rats on highly purified diets. The recent work of Hartman, Cary and colleagues², of the U.S. Department of Agriculture, has amply demonstrated the presence of components of the so-called 'animal protein factor' in casein which has not been subjected to washing or extraction.

Until the outbreak of the Second World War in 1939, caseins of guaranteed purity were prepared in Great Britain by Glaxo Laboratories, Ltd. Their products included an 'Ashless Extracted' casein suitable for studies of vitamin A and vitamin D, a 'Riboflavin-Free' casein suitable for studies of the vitamin B complex, and other grades of casein required for many types of experimental diets. War-time difficulties caused a cessation of supplies, and by the end of the War all workers in Britain who were concerned with biological and microbiological studies requiring purified casein were faced with an urgent problem of supplies. For a time a highly purified casein was available from the United States. It was guaranteed to be free from water-soluble

vitamins B, C and G (riboflavin) and fat-soluble vitamins A and B. It contained as a typical analysis:

N	15.40 per cent
Casein (N x 6.38)	98.25 "
Ash	0.85 "
Moisture not above	5 "

It was an excellent preparation, but was too costly in dollars to be long available; and strenuous efforts in Britain and in other milk-producing countries of the Commonwealth, particularly in New Zealand, finally led to an arrangement by which Messrs. Genatosan, Ltd., a member of the Fison group of companies, undertook to prepare a purified casein by a process of successive treatments with dilute acetic acid and sodium chloride. Without use of other solvents which, rightly or wrongly, was considered undesirable, it was impossible to obtain a product entirely free from vitamins of the B-complex, but a suitable specification was agreed upon and the label of a recent batch of Genatosan low-vitamin casein reads as follows:

Appearance	Cream coloured powder
Loss at 100° C.	Not more than 5 per cent
Protein (by nitrogen)	Not less than 90 per cent
Ash	Not greater than 1 per cent
Amino hydrochloride	Not greater than 1 part per million
Riboflavin	Not greater than 0.25 part per million
Nicotinic acid	Not greater than 1 part per million
Pantothenic acid	Not greater than 0.75 part per million

Moreover, a special analysis of every batch of casein can be obtained on application to Genatosan Laboratory. The provision of such material is an invaluable service for those who require exact knowledge of the vitamin and protein content of diets and media, and involves great labour and expense which inevitably makes the cost of the purified casein high. However, in view of the need for precise control of diets in nutritional research and especially in experimental studies of the factors of the B complex, the outlay must be accepted.

In Queen Elizabeth College, for example, we are carrying out studies of the nature of growth factors required by rats and of the specific effects of purified diets on their blood picture. The low-vitamin casein of Genatosan, Ltd., is proving a satisfactory substitute for caseins previously used, and during the past five years has provided a constant source of protein yielding consistent biological responses. A test of its adequacy has been carried out by measuring the growth response over relatively long periods of rats receiving highly purified diets complete so far as present knowledge of growth factors is concerned. Zucker and colleagues³ showed that inadequacy of dietary protein was indicated by failure to attain a straight line when the logarithm of the weight increase was plotted against the reciprocal of the time. The use of this method was shown by Copping, Crowe and Pond⁴ to be applicable to testing the nutritive value of a number of different caseins. Further studies⁵ on the Genatosan product have produced growth curves which are not significantly different from those reported in the earlier paper. In experiments involving deprivation of a single member of the vitamin B complex, such as pyridoxine or pantothenic acid, very rapid depletion of rats has occurred, with development of characteristic signs of the deficiency.

This laboratory is not alone in making such studies. It is only necessary to look at the nutritional literature currently appearing in Great Britain to realize what a serious problem it would be if any breakdown in

the supply of purified casein occurred at the present time, when many laboratories are deeply involved in nutritional studies that depend basically on the use of balanced purified diets.

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OBITUARIES

Prof. Selig Brodetaky

SELIG BRODETAKY was a man of distinguished and diversified gifts. His position as Senior Wrangler at Cambridge in 1908 showed the mathematical promise that was in him as a young man, and he later specialized in applied mathematics, particularly in aerodynamics, and published much in that field. He was a brilliant expositor and teacher on mathematical subjects, never failing to hold spellbound his hearers whether students of pure and applied science or people of a more general character. He was much sought after as a lecturer on astronomy, revealing the wonders of the heavens to popular audiences, and in this he carried on the tradition of Sir Robert Ball, the Irish astronomer, whose pupil he was. He wrote several text-books on mathematical subjects, mechanical principles of the aeroplane, nomography, etc.; his biography of Sir Isaac Newton was much appreciated by a wide variety of readers.

To regard Brodetaky, however, solely as a scientific man would be to convey little idea of the wider scope of his talents. In addition to mathematics, his main interests were Zionism and the cultivation of the Hebrew language as a medium of ordinary intercourse among Jews. In pursuance of his dream to see the Jews established in the traditional land of their forebears, he was indefatigable in his labours, and travelled by land, sea and air over all the four continents, lecturing and expounding his views and aspirations for the Jewish people. There would seem little doubt that these years of strain and over-exertion led to that ultimate exhaustion which lay at the root of his final illness. During these journeyings the world over, Brodetaky established many contacts with numerous nations and personalities. He did not merely confine himself to Judaism in his wanderings, for he noted intensively systems of government, social manners of life, school and university education, etc. The result of these wide experiences was that his contributions to debates on educational and academic policy and development on the wide scale were recognized as particularly valuable.

Selig Brodetaky was born in Russia, near Odessa, into a poor but cultured home. His father was the traditional Jew, mighty in the Scriptures and well versed in the Talmud. Brodetaky used to relate that he was born at midnight and hence could not say which of two dates was his birthday. On account of the ever-recurrent pogroms against the Jews in Russia, his father decided to leave that country and

to settle with his family in England. He migrated to the East End of London, which according to the scanty information he could gather was about the only place in England where foreign Jews could hope to get a footing. He arrived entirely ignorant of the English language or of English customs, but by grim determination he succeeded in getting a foothold. He then summoned his wife and four small children to join him, and she had to cross Europe unaided with a baby girl to be carried in her arms. Brodetaky as a child of four years of age remembers them hiding in a hen-coop until a kindly army officer signalled to them after nightfall that now was the time to cross the frontier; while crossing, the baby in arms started to cry, but her mother pushed her shawl into the child's mouth. Their struggle for existence in London during their first years was rigorous, for they lived in a block of buildings surrounding a courtyard with twenty families to one pump situated down in the area. All the ultimately large family had to toil hard for daily bread from their childhood days, but they made good in the end.

Brodetaky was educated at the Central Foundation School, London, and by the aid of scholarships he entered Trinity College, Cambridge. After being placed Senior Wrangler in Part I of the Mathematical Tripos, he won a good position in Part II of the Tripos and thereafter studied on the Continent of Europe at the University of Leipzig. He joined the mathematical staff of the University of Bristol, whence he went to Leeds in 1920, becoming professor of applied mathematics four years later. He left Leeds in 1948 on his appointment as president of the Hebrew University at Jerusalem, but ill-health supervened, and he had to resign and come back into retirement in England. He died in London on May 18 at the age of sixty-six and is survived by his widow, Mania Berenbhum, of Bialystok, and a son and daughter.

In temperament, Brodetaky was a very charming man, most obliging in co-operating with his colleagues and ever ready to help a student in financial or other difficulties. He leaves a very pleasant memory behind him.

WILLIAM P. MILNE

Prof. F. LI. Hopwood

THE sudden death on May 2 of Frank Lloyd Hopwood is a heavy and unexpected blow to his many friends all over the world and leaves a conspicuous gap among the pioneers of medical physics. It seems impossible that this large, impressive, and yet so friendly figure has passed from our scene and will no longer encourage, or perhaps gently reprove, the actions of those individuals, single or corporate, working in his field.

Hopwood's scientific interests were wide—perhaps even too wide, yet befitting a rapidly growing borderline subject where the possibilities of immediate or ultimate application of physics to human welfare so attracted him. First as demonstrator, and later as professor of physics in the Medical College of St. Bartholomew's Hospital, London, he was active early in the radiological field; first in the application of the then new Coolidge tube and high-tension techniques and their possibilities of use in procuring more penetrating and therefore more effective X-radiations in the treatment of cancer, as well as in the more physical studies of radiation dosimetry. Later, as a member of the International Commission on Radiological Units, he played an important part in the

discussions leading to the present definition of the unit of dose. It is also to be remembered that in collaboration with such pioneers as Strangeways, Canti and Donaldson at 'Barts', he was responsible for the physical aspects of some of the earliest work using tissue cultures in the study of the effects of ionizing radiations on living cells.

Long an authority in the physical aspects of the use of radium in the treatment of disease, he realized very quickly the importance to medicine of the discovery of artificial radioactivity, and particularly its production by neutrons, so that it is no accident that the important Skillard-Chalmers type of reaction was brought to light by those workers in his department. The physico-chemical effects of neutron irradiation, particularly in respect of biological action, early interested him, as may be seen from the Silvanus Thompson Memorial Lecture delivered by him to the Institute of Radiology.

His other main scientific interest lay in the field of sound, audible or supersonic. Undoubtedly stimulated by his work during the First World War with the Admiralty Research Station at Harwich when he worked on the detection of underwater sound, Hopwood built a supersonic generator and showed the

destructive power of this 'radiation' on such simple organisms as *Nitella* and carried out many experiments on the subject. This interest in sound persisted to the end of his life and, characteristically enough, the last conversation I had with him a week or two before his death was filled by an account, delivered with boyish enthusiasm and much dexterous manual demonstration, of experiments he had been carrying out at home on the strange and fascinating things to be seen in a kitchen sink in jets of water impinging on perforated metal.

One other aspect of Hopwood's work must be mentioned. He was perhaps at his best as a teacher. Lucid, thorough, impressive and enthusiastic, even first-year medical students fell under his spell, as well they might, for many of them 'off stage' had known his fatherly interest in them when as dean he had at once admonished and shielded them in their misdeeds.

Hopwood was called on to undertake much committee work, and mention must be made of the help he rendered on their governing bodies to the Physical Society, the Institute of Radiology (of which he was president) and, among many others, to the British Empire Cancer Campaign. W. V. MAYNEORD

NEWS and VIEWS

The Queen's Birthday Honours List

THE Queen's Birthday Honours List includes the names of the following scientific men and others associated with scientific work:

Baronet: Sir Russell Brain, president of the Royal College of Physicians of London.

Knights: Dr. A. Chester Beatty, vice-patron (formerly president) of the Royal Cancer Hospital, London; Dr. Gavin R. de Beer, director of the British Museum (Natural History); Dr. Ian Clunies-Ross, chairman of the Commonwealth Scientific and Industrial Research Organization, Australia; Dr. Arnold A. Hall, director of the Royal Aircraft Establishment, Farnborough; Dr. Alexander P. Murphy, president of the Royal Australian College of Physicians; Prof. Francis E. Simon, professor of thermodynamics, University of Oxford; Dr. Thomas M. Taylor, principal and vice-chancellor of the University of Aberdeen; Prof. Alexander R. Todd, professor of organic chemistry, University of Cambridge, and chairman of the Advisory Council on Scientific Policy.

C.M.G.: Ivor Bowen, lately head of the United Kingdom Ministry of Supply Staff, Australia, now principal director of equipment research and development (air), Ministry of Supply; R. J. Simmons, adviser on animal health to the Secretary of State for the Colonies; Dr. A. Topping, dean of the London School of Hygiene and Tropical Medicine.

C.B.E.: W. G. Alexander, deputy secretary, Agricultural Research Council; G. H. Bacon, lately director of agriculture, now agricultural adviser to the Sudan Government; H. Davis, chief pharmacist, Ministry of Health; Dr. G. E. R. Deacon, director of the National Institute of Oceanography, Wormley, Surrey; Dr. M. S. Jones, director of the Social Rehabilitation Unit, Belmont Hospital, Sutton, Surrey; Dr. W. Idris Jones, director-general of research, National Coal Board; R. S. Marshall, inspector-general of Animal Health Services, Nigeria; Prof. L. H. Martin, professor of physics in the Univer-

sity of Melbourne; K. T. Parker, keeper of the Ashmolean Museum, University of Oxford; V. A. Pask, chief engineer, Headquarters of the British Electricity Authority; H. G. Raggatt, secretary of the Department of National Development, Australia; Prof. L. Rosenhead, professor of applied mathematics, University of Liverpool; D. R. Rosevear, inspector-general of forests, Nigeria; A. E. Russell, director and chief designer, Bristol Aeroplane Co., Ltd.; H. L. Shrimpton, chief livestock husbandry advisory officer, National Agricultural Advisory Service; H. Tongue, chief engineer, Atomic Energy Research Establishment, Harwell, Berks; H. L. Verry, assistant secretary, Department of Scientific and Industrial Research; J. R. Whinfield, of Imperial Chemical Industries, Ltd., for services in the invention of 'Terylene'; I. D. Wratten, lately president of the Royal Photographic Society of Great Britain; Prof. C. M. Yonge, regius professor of zoology, University of Glasgow.

I.S.O.: J. D. Broatch, deputy director of agriculture (cocoa industry), Gold Coast; G. A. Elliott, director of surveys, British Honduras.

Mathematics at Reading: Prof. E. H. Neville

IN July, Prof. E. H. Neville retires from the chair of mathematics at the University of Reading, which he has held since 1919. His publications cover a wide field of mathematics: in 1922 his "Prolegomena to Analytical Geometry" gave a consistent logical basis to the concepts of complex space and ideal space, and in 1944 a skilful combination of technique and logic in his "Jacobian Elliptic Functions" developed beauty and order in a domain which had often seemed overgrown with an amorphous welter of formulae. Prof. Neville was president of Section A. (Mathematics and Physics) of the British Association in 1950, and his presidential address, "Mathematical Notation", is a penetrating essay towards the study of the influence of symbolism on the development of mathematical thought. He also served for many

years on the Tables Committee of the British Association, now the Tables Committee of the Royal Society, and his own table, "Farey Series of Order 1025", was the first volume of the Royal Society series. The belief that the professional mathematician need not concern himself with pedagogical problems has never been accepted by Prof. Neville, and he has taken a leading part in the work of the Mathematical Association in the improvement of the teaching of mathematics. In particular, the Association's reports on the teaching of geometry in schools owe much of their power and authority to Neville's committee work. He was librarian to the Association during 1923-53, and president in 1934. Between the two World Wars, Prof. Neville was the British representative on the Central Committee of the International Commission on the Teaching of Mathematics.

Dr. R. Rado

PROF. NEVILLE will be succeeded by Dr. Richard Rado, at present reader in mathematics in King's College, London. Dr. Rado, who is forty-eight and Hungarian born, studied first at the Universities of Berlin and Göttingen, taking his Dr.phil. (Berlin) in 1933, before going to Cambridge to study under Prof. G. H. Hardy, where he took his Ph.D. in 1935. During 1936-47 he was on the staff of the Mathematics Department at Sheffield, becoming a naturalized British subject in 1940, and in 1947 he was appointed to his present post in London. He is at present secretary to the London Mathematical Society, having been a member of the Council since 1948. Dr. Rado has published in all nearly fifty papers, many of them very substantial, in various learned journals. His main interest has been in general problems of combinatorial analysis, and especially in results of the type: "Every random system of some specified class contains a highly regular sub-system of some other specified class", such problems arising in number theory and in algebra, and being in any event worth studying for their own sake. His work also includes researches on graphs (one-dimensional topology), affine invariants of convex bodies, inequalities (he assisted in the preparation of the book "Inequalities" by Hardy, Littlewood and Polya), and transfinite numbers, where properties are sought which reveal differences of structure and behaviour of such numbers. The high distinction of his researches, the authority of his scholarship and his well-known brilliance as a lecturer have all contributed to the powerful influence which he has latterly exerted on the development of mathematics, particularly in London.

Biological Division of the Wellcome Research Laboratories: Colonel H. W. Mulligan, C.M.G.

COLONEL H. W. MULLIGAN assumes on September 1 the appointment of head of the Biological Division, The Wellcome Research Laboratories, Beckenham, previously held, in association with other duties, by Dr. J. W. Trevan, who retired in August 1953. After graduating from the University of Aberdeen in 1923, Colonel Mulligan served in the Indian Medical Service until its disbandment in 1947. He was posted to its Medical Research Department in 1928 and remained in this branch except for three years on active service during the Second World War, when he ultimately became consultant malariologist, Persia and Iraq Command. Among the appointments he held in India were those of director of the Pasteur Institute, Coonoor, and later of the Central Research

Institute, Kasauli, where at an earlier date he was in charge of the Serum and Vaccine Department. In 1947 he went to West Africa to create an institute for research into all aspects of trypanosomiasis, both in human beings and in domestic animals. This task is now completed, and the West African Institute for Trypanosomiasis Research is an actively functioning and successful organization. Colonel Mulligan is the West African representative on the Scientific Council for Africa, and a member of the International Scientific Committee for Trypanosomiasis Research and of the World Health Organization Expert Panel on Parasitic Diseases. During the past three years he has been engaged in planning the co-ordination of medical research activities in the West African Colonies. His efforts in this matter did much to pave the way for the inauguration of the West African Council for Medical Research, which was established by ordinance a few months ago.

Comptroller-General of the Patent Office:

Mr. J. L. Girling

MR. JAMES LAWRENCE GIRLING, who has been appointed comptroller-general of Patents, Designs and Trade Marks in succession to the late Sir John Blake, was born on July 8, 1901, and was educated at Eastwood Ho! College, Felixstowe, during 1910-14 and at Ipswich Secondary School 1914-18. He became a Draper's Scholar at East London College during 1918-21. He was awarded a London B.Sc. degree with second-class honours in electrical and mechanical engineering and in his last year studied civil engineering. Mr. Girling was appointed to the Patent Office as an assistant examiner in November 1921, was promoted to examiner in 1927 and to senior examiner in 1937. He served in the R.A.F. from 1939 until October 1945, leaving with the rank of squadron leader. He was promoted to the grade of principal examiner in the Patent Office *in absentia* in April 1944 and superintending examiner in April 1950, and was called to the Bar at Gray's Inn in the same year.

European Organization for Nuclear Research

THE European Organization for Nuclear Research is the direct outcome of a general inquiry initiated in October 1946 by the Economic and Social Council of the United Nations into the establishment of United Nations research laboratories. It was established by the convention of July 1, 1953, adopted by representatives of Belgium, Denmark, France, the German Federal Republic, Greece, Italy, the Netherlands, Norway, Sweden, Switzerland, the United Kingdom and Yugoslavia, and will come into force when ratified by Switzerland and six other countries. A report on this general question was published in December 1948, and at a meeting of Unesco in Florence in 1950 a resolution was adopted authorizing the Director-General of Unesco to inquire into the needs and possibilities of such regional research centres and to make initial surveys of cost estimates and locations. No specific fields of research or regions were mentioned in this resolution; but out of it arose in 1952 the European Council for Nuclear Research, and two years of work has now led to the establishment of a permanent organization for nuclear research on a site at Meyrin, near Geneva. A pamphlet entitled "European Co-operation in Nuclear Research" (Unesco and its Programme, No. 11. Pp. 26. Paris: Unesco; London: H.M.S.O., 1954. 1s. net) describes the purposes and resources of

this new Organization and includes a clear account of the development of this type of international scientific collaboration and of the work of the European Council for Nuclear Research in drafting the convention and organizing other forms of co-operation in nuclear research. The cost of the activities of the Organization, including construction and equipment of the Laboratory, is estimated at £10 million for the first seven years, towards which the United Kingdom will contribute about £2.4 million. The initial equipment will include a proton-synchrotron and a synchrocyclotron designed to produce proton beams of 25 GeV. and 600 MeV., respectively. Excerpts from the convention are annexed to the pamphlet.

Steroids for Chromatography

THROUGH the co-operation between a number of fine-chemical companies and university laboratories in the United States, steroid preparations for use as reference standards for paper chromatographic techniques are now available. This service has been undertaken by the United States Pharmacopeial Convention, 46 Park Avenue, New York 16, which has announced the issue of the first set of twenty-four steroids of importance for identification purposes. Many of these have hitherto been unobtainable from commercial sources. The price of the complete set is 60 dollars; but the individual steroids can be obtained for 3 dollars each. They are diluted with talc in the proportion of 1:100, and from this mixture the steroid can be readily extracted with an appropriate solvent. Most of the steroids contain trace amounts of contaminants which will not normally interfere in chromatographic procedures. Physical data of the steroids are set out in an accompanying leaflet, which also provides information concerning the programme of the United States Pharmacopeia service. It is proposed to issue further sets of steroids, and in due course a total of fifty-two steroid standards will be available to all parts of the world.

Optical Society of America: Annual Meeting

THE thirty-eighth annual meeting of the Optical Society of America was held at the George Eastman House, Rochester, New York, during October 15-17, 1953. The meeting was preceded by a special visit to the Corning Glass Works, where more than a hundred and fifty members of the Society were greeted by Dr. E. U. Condon, the director of research, and listened to a talk by Dr. W. W. Shaver, the manager of the product development division, on applied and theoretical glass problems, and to a discussion, by members of the staff of the Corning laboratories, on the properties of fused silica. The annual banquet was given on the evening of October 16, at which the Frederic Ives Medal of the Society was presented to Prof. H. M. Randall, of the University of Michigan. At the annual business meeting on the next day the new officers were installed: *President*, Deane B. Judd; *Vice-President*, R. A. Sawyer; *Secretary*, A. C. Hardy; and *Treasurer*, W. W. Graefer. The programme of the technical sessions comprised seventy-five contributed and three invited papers. The titles and abstracts of these papers are printed in the September issue of the Society's *Journal* (43, 811; 1953), and a brief report of the proceedings of the annual meeting in the November issue (43, 1126; 1953). The invited papers dealt with three-dimensional and wide-angle projection. Three-dimensional presentation with polarized light

was discussed and demonstrated by E. H. Land; the cinemascope method of wide-angle photography by J. R. Benford; and the cinerama process by F. Waller (read in his absence by F. Tuttle).

Grant-aided Agricultural Colleges in Britain

THE Minister of Agriculture and Fisheries has appointed a committee to inspect the grant-aided agricultural colleges, with the following terms of reference: "To examine and report to the Minister of Agriculture and Fisheries on the work of the grant-aided Agricultural Colleges and to make recommendations as to the grants to be made to them for the five academic years beginning October 1, 1954". The members of the Committee are: Dr. K. A. H. Murray, chairman of the University Grants Committee; the Hon. Mrs. Ralph Ascheton, a land agent and farmer in Lancashire; Prof. H. G. Sanders, professor of agriculture, University of Reading; and Mr. G. A. Nott, a leading West Midlands farmer.

Scholarship Grants for Education in Plastics

THE trustees of the Plastics Industry Education Fund have recently announced that, in addition to allotting £1,000 for the third year in succession for training grants to students working full time for a science degree, £1,000 a year for the next two years has been allotted for bursaries for students taking the two-year diploma course at The Borough Polytechnic, London. This course, which was started last September, has proved very useful in training young men wanting to enter the industry. To increase facilities for training in plastics technology in the Midlands, £1,000 a year for the next two years has been allocated for scholarships to students taking the full-time associateship course at the Birmingham College of Technology. This course has been available for some time, and it is hoped that the offer of scholarships will induce sufficient students to undertake the course and keep it going from year to year.

Lady Tata Memorial Trust: Awards

THE following new awards have been made by the Lady Tata Memorial Trust for research on leukaemia and allied diseases: *Grants for research expenses*, Dr. A. Sreenivasan (Department of Chemical Technology, University of Bombay); *Scholarships (whole-time or part-time)*, Dr. J. Ringsted (Fibiger Laboratories, University Institute for Pathological Anatomy, Copenhagen) and Dr. J. Rygaard (Radium Institute, Copenhagen); *Part-time scholarship and grant for research expenses*, Dr. M. Seligmann (Institut Pasteur, Paris). In addition, the various awards to the following research workers, which have previously been announced (see *Nature*, 171, 1098; 1953), will be renewed for another year: Dr. F. Klemmeyer-Nielsen and Dr. N. A. Stenderup (Aarhus), Dr. J. Nordmann and Dr. R. Robineaux (Paris), Dr. J. Kieler and Dr. Ragna Reak-Nielsen (Copenhagen), Dr. Astrid Fagraeus and Dr. B. Thorell (Stockholm), and Dr. G. Negroni (London).

Exhibition in Manchester of the North-West Branch of the Institution of Electronics

THE ninth annual exhibition of the North-West Branch of the Institution of Electronics will be held in the Manchester College of Technology (Sackville Street, Manchester) during July 14-20 (10 a.m.-10 p.m.; except July 14, 2.30 p.m.-10 p.m.; and July 17, 10 a.m.-7 p.m.). The exhibition will consist of two sections: a scientific and industrial research

section, composed of displays from universities, research associations, hospitals, etc.; and a commercial section devoted to manufacturers' products. Altogether there will be displays from more than fifty exhibitors. In addition to an extensive programme of lectures and film shows, visits will be arranged to the University of Manchester Computing Department. Exhibition catalogues (1s. 6d. post paid), lecture and film show programmes (4½d. post paid) and further information are available from the honorary exhibition organizing secretary, W. Birtwistle, 78 Shaw Road, Thornham, Rochdale, Lancs.

Congress In Leyden of the International Society for Cell Biology

THE eighth congress of the International Society for Cell Biology, known as the Cytology Congress, will be held in Leyden during September 1-8, under the presidency of Prof. E. Newton Harvey, of Princeton University. Full members of the Society, and candidates for membership approved by the International Committee, are automatically entitled to attend the congress and to introduce one guest. The programme of symposia, at which invited papers will be read, will include the following topics: induced enzyme synthesis; the formation of the intracellular matrix in plant and animal tissues; immunobiological concepts of cellular growth and differentiation; biochemistry of gene action; thyroid secretion; nuclear and chromosome structure; mitochondria; cell division and mitotic poisons; morphogenetic interactions between cells; virus synthesis; the active cell surface; and submicroscopic structure of cytoplasm. The sessions on mitochondria, nuclear and chromosome structure and submicroscopic organization of cytoplasm form a special conference on the "Fine Structure of Cells", held under the auspices of the International Union of Biological Sciences. At the general sessions members and their guests may contribute papers on topics of their own choosing, and notification should be made before July 1. Further information can be obtained from the secretary of the Congress, Dr. W. K. H. Karstens, Botanical Laboratory, Nonnensteeg 3, Leyden.

In conjunction with the congress, the National Museum for the History of Science, Steenstraat 14, Leyden, is organizing an exhibition, "From Magnifying Glass to Eye of Science", to be held during June 25-September 19. The exhibits will include microscopes, demonstrations of instruments, drawings, manuscripts and portraits, etc., from the period of about 1630-1880. A catalogue will be available.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: J. W. Pursglove (senior agricultural officer, Uganda), director of botanical gardens, Singapore; G. D. Shaw (veterinary officer, Northern Rhodesia), chief veterinary research officer, Northern Rhodesia; B. L. Mitchell (teetee entomologist, Nyasaland), biologist, Game and Teetee Control Department, Northern Rhodesia; G. D. Stockwell, veterinary officer, Tanganyika; E. S. Clayton, economist/statistician, Economic Research Division, Kenya; W. S. Foster, soil survey officer, Nigeria; R. A. Smart, assistant conservator of forests, Northern Rhodesia; J. H. Smith, veterinary officer, Nigeria; T. F. Twist, meteorologist (British Caribbean Meteorological Service), Trinidad.

Announcements

SIR HAROLD ROXBEE COX, chief scientist of the Ministry of Fuel and Power since 1948, is resigning from the public service on June 30, in order to take up appointments in the engineering industry.

THE Lord President of the Council has appointed Sir Hugh Beaver to be chairman of the Advisory Council for Scientific and Industrial Research in succession to Sir Ian Hailbron, who retires on September 30 on completion of his term of office. Sir Hugh Beaver, who has been a member of the Advisory Council since 1952, is managing director of Arthur Guinness, Son and Co., Ltd.

At the University of Cambridge on June 10, honorary degrees were conferred on the following, among others: *Sc.D.*, Prof. P. M. S. Blackett, professor of physics at the Imperial College of Science and Technology, University of London, and Sir Charles Dodds, Courtauld professor of biochemistry in the University of London; *Litt.D.*, Miss Gertrude Caton-Thompson, known for her work in archaeology.

PROF. J. McCUNE, professor of veterinary anatomy in the Royal Veterinary College, London, has been appointed acting principal of the College in succession to the late Prof. J. B. Buxton.

PROF. P. PRUVOST, director of the Institut de la Houille, Paris, and *correspondant* for the Mineralogical Section of the Paris Academy of Sciences, has been elected a member of the Mineralogical Section of the Academy in succession to the late E. de Margerie.

THE following appointments have been made in the University College of North Staffordshire: Mr. A. G. N. Flew, at present lecturer in the Department of Moral Philosophy, University of Aberdeen, to be professor of philosophy; Dr. D. G. Holloway, to be assistant lecturer in physics.

DR. C. B. B. DOWNMAN, senior lecturer at St. Thomas's Hospital Medical School, London, has been appointed to the University of London readership in physiology tenable at the Royal Free Hospital School of Medicine.

THE Sports Turf Research Institute will hold a silver jubilee conference on July 1 at its St. Ives Research Station, Bingley, Yorks, in celebration of its founding in 1929. Besides the four principal lectures of the conference, facilities will be provided for inspecting the work of the Institute, and a display of machinery and equipment will be staged. Application forms for the conference, to be returned by June 25, can be obtained from the Research Station.

It is proposed to institute a special international award, to consist of a bronze medal and a scroll, for outstanding work in the field of venereal diseases and non-venereal treponematoses, the award to be administered by the World Health Organization. It is hoped to collect enough money to make it an annual award, and interested individuals and organizations are invited to contribute to the establishment of this special fund, cheques being made payable to "The International Treponematoses Award Fund". In Great Britain the temporary treasurer is Dr. R. R. Wilcox, of St. Mary's Hospital, London, W.2, and in the United States Dr. Frank W. Reynolds, of the Saratoga Spa, Saratoga Springs, N.Y.

NATIONAL ACADEMY OF SCIENCES

ANNUAL MEETING

THE ninety-first annual meeting of the National Academy of Sciences was held in Washington, D.C., during April 26-28 and was attended by about two hundred of the total of five hundred members that make up the Academy. During the meeting five sessions were devoted to the reading of about forty papers, and in addition there were three symposia of invited papers on the following important fields of current scientific interest: structure and functions of nucleic acids, under the chairmanship of Prof. Linus Pauling (California Institute of Technology); the development and significance of high-energy particle accelerators for nuclear research, under the chairmanship of Prof. I. I. Rabi (Columbia University); and scientific aspects of the International Geophysical Year, under the chairmanship of President Lloyd V. Berkner (Associated Universities, Inc.). Each year the president of a distinguished foreign academy or society is invited to address the Academy, and this year the chief guest of honour and principal speaker was Prof. Per Adolf Geijer, president of the Royal Swedish Academy of Science and formerly director in chief of the Swedish Geological Survey.

At the meeting four awards of the Academy were presented, as follows: *John J. Carty Medal*, to Dr. Vannevar Bush, president of the Carnegie Institution of Washington; *Comstock Prize*, to Dr. William Shockley, of the Bell Telephone Laboratories; *Elliot Medal*, to Prof. Raymond C. Osburn, emeritus professor of zoology, Ohio State University; and the *Public Welfare Medal*, to Dr. Alan Gregg, vice-president of the Rockefeller Foundation.

The Carty Medal, which was established by a group of friends of Dr. John J. Carty when he retired in 1930 from the vice-presidency of the Bell Telephone Laboratories, is awarded at intervals by the Academy for noteworthy and distinguished accomplishments in any field of science coming within the scope and charter of the Academy, without regard to race, nationality or creed. Dr. Bush, who has been president of the Carnegie Institution of Washington since 1939, is distinguished not only for his work as a scientist and engineer but also as an administrator and public servant. In particular, he organized the Office of Scientific Research and Development during the Second World War, which he administered in parallel with his responsibility for the development of the atomic bomb.

The Comstock Prize for advancement of knowledge in electricity, magnetism and radiant energy is awarded every five years from a fund established in 1907 by Cyrus B. Comstock, a member of the Academy. The Prize for 1953 totals four thousand dollars and is awarded to Dr. Shockley "for his pioneering investigations and exposition of electric and magnetic properties of solid materials; in particular for his researches in the conduction of electricity by electrons and holes in semi-conductors". Except for war service, when he was director of research for the anti-submarine warfare operations research group at Columbia University, Dr. Shockley's working career has been at the Bell Telephone Laboratories, which he joined in 1936, and his

researches have led directly to the development of the transistor.

The Elliot Medal, which was established in 1917 by Margaret Henderson Elliot in honour of her father, Daniel Giraud Elliot, is awarded annually for the most meritorious work in zoology or paleontology published each year. The award to Prof. Osburn this year is in recognition of his work "Bryozoa of the Pacific Coast of America", a comprehensive treatise on this complicated group of marine organisms which are of scientific interest both as living material and in fossil form and as aids to geological dating. Prof. Osburn was appointed professor of zoology and head of the Department in Ohio State University in 1917, retiring in 1942, and during 1945-53 he held the position of research associate on Bryozoa of the Hancock Expeditions of the University of Southern California.

The award of the Public Welfare Medal is made possible by a fund established in 1913 in honour of Marcellus Hartley by his daughter, Mrs. Helen Hartley Jenkins, the purpose of the Medal being "... to mark the appreciation of the National Academy for eminent service to the public, performed without a view to great monetary gains and by methods which, in the opinion of the Academy, are truly scientific". This year's recipient, Dr. Gregg, has been associated with the Rockefeller Foundation since 1919, being successively associate director, Division of Medical Education; associate director of medical sciences; director of medical sciences; and, since 1951, vice-president of the Foundation. Not only through the Foundation but in other capacities as well, Dr. Gregg has actively participated in medical education and research in the United States and abroad; in supporting the promotion of basic research, he has always been a champion of 'risk research'. As chairman of the Committee on Biology and Medicine of the Atomic Energy Commission since its organization, he has effectively guided the direction of its activities in such a way that basic research has prospered equally with other research activities, and at all times he has stood for freedom in research activities and open interchange of knowledge whenever such freedom and interchange do not jeopardize national security.

The following were elected officers of the Academy: *President*, Dr. Detlev W. Bronk, president of the Rockefeller Institute for Medical Research, New York City; *Foreign Secretary*, Dr. John G. Kirkwood, director of the Sterling Chemistry Laboratory, Yale University; *New Members of Council*, Prof. Farrington Daniels, Department of Chemistry, University of Wisconsin, and Dr. Merle A. Tuve, director of the Department of Terrestrial Magnetism, Carnegie Institution of Washington. The other officers of the Academy, who were elected in previous years and will continue until the expiry of their term of office, are as follows: *Vice-President*, Dr. George W. Corner; *Home Secretary*, Dr. Alexander Wetmore; *Treasurer*, Dr. William J. Robbins; *Members of Council*, Hugh L. Dryden, Robert F. Loeb, William W. Rubey, Wendell M. Stanley and Edwin B. Wilson.

The following have been elected members of the Academy: E. Anderson, professor of botany, Washington University, St. Louis; H. W. Babcock, astronomer, Mount Wilson Observatory, Pasadena; E. C. Bain, vice-president in charge of research and technology, United States Steel Corporation, Pittsburgh; A. K. Balls, professor of enzyme chemistry, Purdue University; J. Bardeen, professor of physics and electrical engineering, University of Illinois; W. Bloom, professor of anatomy, University of Chicago; M. N. Bramlette, geologist, Scripps Institution of Oceanography, La Jolla; W. R. Brode, associate director, National Bureau of Standards, Washington, D.C.; M. Calvin, professor of chemistry, University of California, Berkeley; B. Chance, director of the Johnson Foundation, University of Pennsylvania; R. P. Feynman, professor of theoretical physics, California Institute of Technology, Pasadena; H. O. L. Fisher, professor of biochemistry, University of California, Berkeley; J. B. Fisk, director of research in the physical sciences, Bell Telephone Laboratories, Murray Hill, N.J.; J. P. Guilford, professor of psychology, University of Southern California, Los Angeles; N. Jacobson, professor of mathematics, Yale University; G. E. Kimball, professor of chemistry, Columbia University; W. E. Lamb, professor of physics, Stanford University; E. M. Landis, professor of physiology, Harvard Medical School; E. Mayr, professor of zoology, Harvard University; W. F. Meggers, chief of the Spectroscopy Section, National Bureau of Standards, Washington, D.C.; A. E. Mirsky, member of the Rockefeller Institute for Medical Research, New York; B. O'Brien, vice-president, American Optical Company, Southbridge, Mass.; W. K. H. Panofsky, professor of physics, Stanford University; A. Petrunkevitch, professor emeritus of zoology, Yale University; A. R. Rich, professor of pathology, School of Medicine, Johns Hopkins University; J. H. Steward, professor of anthropology, University of Illinois; E. H. Vestine, chairman of the Section on Statistical and Analytical Geophysics, Department of Terrestrial Magnetism, Carnegie Institution of Washington; F. H. Westheimer, professor of chemistry, University of Chicago; R. H. Wetmore, professor of botany, Harvard University; A. E. Whitford, professor and director, Washburn Observatory, University of Wisconsin.

The following have been elected foreign associates of the Academy: Sir Macfarlane Burnet, director of the Walter and Eliza Hall Institute for Medical Research, Melbourne; Albert M. G. R. Portevin, consulting engineer, Paris; and Otto Renner, professor and head of the Botanical Institute and Garden, Munich.

REACTIONS OF THE HUMAN BODY TO INJURY

THE British Council has done good service to the serious student of disease by bringing together* a number of articles which show very clearly the changing attitude to injury reactions. No longer can this topic be considered as the sole province of pathology. Indeed, it is all too clear that no progress need be expected unless the attack be planned on the widest possible front. The chemist and physicist,

the clinician, bacteriologist and pathologist must each play his part in the study of what goes on in the injured tissues and of the factors that modify the responses until death or recovery occurs. This re-birth of the old doctrine of inter-relationship between constitutional factors and local tissue response owes a great deal to Sir Edward Mellanby, until lately secretary of the Medical Research Council and himself an original investigator in the field, and it was a felicitous thought to persuade him to write the introduction to the British Council's symposium.

Prof. G. Payling Wright tells a fascinating story about tetanus which is largely the outcome of his own recent work. Ingenious experiments have shown how the toxin of this unpleasant germ reaches the central nervous system and exerts its effects at the synapses of the spinal cord. Prof. Wright indicates how infection may be prevented and pleads for general immunization of the young.

Under the title of "Gas Gangrene", Prof. C. L. Oakley reviews the present-day knowledge of anaerobic infections. His masterly exposition of their genesis shows that changes in oxidative reduction potentials, pH requirements and various other disturbances in damaged muscle provide ideal conditions for the nourishment and growth of anaerobic bacteria. The various toxins manufactured by these organisms are characterized so far as that is possible and their modes of action discussed. In this way precision replaces empiricism in the investigation and treatment of these diseases.

Dr. J. B. Cavanagh and Prof. R. H. S. Thompson provide much food for thought in their brief but admirable review of demyelination. They conclude that several dissimilar processes, which range from deficiency states to anti-cholinesterases, have this common feature. The results of their further study will be awaited with interest, since it is likely that here again the enzymic factors will provide the clue.

An unusual article comes from Drs. J. D. Judah and W. G. Spector, who apply modern enzymological techniques to the diseased cell. Much of this information is derived from the authors' original work on poisons such as dinitrophenol and carbon tetrachloride, and it would seem that we are on the way to resolving the problem of some cell injuries in terms of biochemical disturbance. This, too, is the main theme of Dr. H. Cullum's paper on war gases, some of which interfere with enzyme systems and so lead to permeability changes in the endothelium of blood vessels and upset fluid equilibrium in the body. The latter subject is well discussed by Dr. F. C. Courtice, who defines the role of altered lymph flow from damaged tissues and assesses its connexion with haemodynamics and osmotic properties of the blood. Dr. Courtice's point of view recalls the stimulating attack made about fifty years ago by the late Prof. E. H. Starling, and possesses the special merit of being based on his own superb technique for the measurement of lymph flow.

No compilation on injury can neglect the subject of 'shock', and in this symposium full justice is done to various aspects of this elusive problem. Prof. H. N. Green and Dr. H. B. Stoner describe their stimulating hypothesis, which links shock with carbohydrate metabolism; Dr. R. T. Grant summarizes his notable clinical studies made during the Second World War and Dr. J. P. Bull draws upon his wide experience in a helpful article on burns. Shock naturally raises the question of blood transfusions, and Dr. R. Bodley Scott deals with the

* *British Medical Bulletin*, 10, No. 1 (1954). Pp. 72. (Medical Dept., British Council, 65 Davies Street, London, W.1.) 15s.

clinical aspect, while a band of workers, Sir Alan Drury, Dr. P. L. Mollison, Dr. W. d'A. Maycock and Dr. Margaret E. Mackay, review the problems of blood storage, plasma and its substitutes.

Finally, Dr. W. Ritchie Russell discusses head injuries, with an admirable blend of physiology and surgery which is a model of clinical investigation.

Each of these articles is well documented and makes good reading, since a leading principle is kept well to the fore even when information is scanty and apparently contradictory.

The scientific editor, Dr. W. G. Spector, is to be congratulated on the success of his efforts.

V. UDALL

WORKABLE PEAT RESOURCES OF SCOTLAND

WORKABLE deposits of peat, equivalent in value as fuel to twenty years output of coal, or 500 million tons, are estimated to be available in Scotland as the result of a painstaking inquiry carried out by the Scottish Peat Committee, which had been set up in 1949 and reported in 1953*. This accessible reserve occupies a total area of 1,625,000 acres, covered to a depth of 2 ft. of peat, and contains a thousand million tons of solid fuel, some 600 million tons consisting of mosses of which the depth, accessibility and other features make them suitable for utilization. In the associated inquiries into the winning and utilization of the peat, the Committee kept prominently in mind the prospect that ultimately much of the land now under peat might be reclaimed for agriculture or forestry.

In a number of European countries, perhaps more richly blessed by reserves of peat than is Scotland, peat production has been developed on a considerable scale, and mechanical methods of winning fuel have been well advanced. The various methods available were examined by the Committee. Thus, peat produced by automatic plants, with excavators, macerators and spreaders for drying, is likely to be more expensive than coal in Britain unless smaller types of machines can be made to reduce costs substantially.

Hydro-peat—that is, raw peat disintegrated into a slurry by a high-powered water-jet, pumped from the bog to a drying field and cut into blocks—might have some application if a cheap method of removing water could be devised; but the Committee considers that this is not yet practicable. In the production of milled peat a horizontal cut of about $\frac{1}{4}$ in. thickness is made, the machine operating on the same principle as a motor grass-mower. The milled peat, after preliminary drying *in situ* and harvesting, is taken to a drying and briquetting plant. The product has a net calorific value of 8,000 B.Th.U. per lb., and is relatively dense and transportable. The process requires fairly favourable climatic conditions for drying, and, accordingly, in Scotland the number of harvests might be limited to some 18–20 in a season. The cost is roughly competitive with coal as delivered to power stations in the north of Scotland.

The technical problem of greatest difficulty is to find an efficient and economical means of reducing the moisture content of peat from upwards of 90 per

cent in the raw state to a level at which it can be burned. Nearly all processes now operating commercially rely on wind and sun to do so. This makes peat production a seasonal operation with expensive seasonal labour. The application of mechanical processes was investigated, but it was found that their suitability has not reached a scale at which their commercial use could be recommended for Scottish conditions. Other processes considered include wet-carbonizing, de-watering by centrifuge and electro-osmosis; but they were all found to be less promising than pressure de-watering. There may, however, be scope for developing some other uses of peat in association with a fuel and power plant—for example, the production of moss litter, or the extraction of waxes. Other processes, such as carbonization, hydrogenation and use as a building material, are considered less hopeful.

Perhaps the most interesting and novel feature of these pioneering efforts has been the application of peat firing to the gas turbine used as a power generator. The attractive features of the gas turbine are the greater flexibility in siting, less demand for cooling water, reduced possibility of damage by abrasion from harmful constituents of its low content of ash, and greater possibilities of more efficient use of the potential heat of the fuel. Thus it may be possible to dry a wet fuel like peat from a higher moisture content by the use of the waste heat available.

The closed-cycle gas turbine has been investigated by the Scotland Hydro-Electric Board. A description is given in the present report of trials with a machine of this type, of some 500 H.P. capacity, in which a flue-gas drier was incorporated to dry peat from a moisture content of 50–55 per cent to a moisture content of 30 per cent, thus enabling it to operate with milled peat or with any of the accepted methods of peat production involving air-drying.

Another gas turbine, of 750 kW. capacity, operating on the open cycle, has been sponsored by the Ministry of Fuel and Power and is already in limited production, and regarded as having reached a stage of proved reliability. A rotary louver drum drier has been ordered and should give valuable information for application to both the open- and the closed-cycle systems. It is estimated that a small peat-burning closed-cycle gas turbine of 2,000 kW. might produce power at a cost comparable with small diesel stations of similar output, but the cost would be much higher than that of power from large hydro-electric schemes. On the other hand, once a large peat-fired plant can be developed, the Committee considers that important economies could result which would enable such a plant to produce power at a cost comparable with large coal-fired steam turbines. Since the report was drafted the Hydro-Electric Board and the Central Electricity Authority have agreed, with assistance from the Government Development Fund, to contribute towards the capital cost of establishing a 2,000-kW. peat-burning unit at Altnabreac, Caithness. Meanwhile, investigations are to go ahead on pressure de-watering and other methods of peat production. An open-cycle machine of 750 kW. and a large press ordered by the Ministry of Fuel and Power are to be included in the developments at the same station. Thus Britain has taken the lead in developing solid-fuel gas turbines. Further, the peat experiments foreshadowed in the report will be watched with great interest in a number of other countries, particularly Ireland, Sweden and Canada.

* Scottish Home Department. Report of the Scottish Peat Committee. Pp. 66+8 plates. (London: H.M.S.O., 1954.) 5s. net.

Another and perhaps no less significant feature of the report is the reference to land development following the winning of the peat. The depopulation of the Highlands may be attributed to the existence of barren areas, costly in the maintenance of social services more abundant in other parts of Britain. The conversion of the peat areas to agricultural use and afforestation requires, beyond the winning of the peat, intensive drainage, the cultivation of arable and pastoral soil conditions, and the features necessary for the planting of trees, namely, a suitable subsoil and absence of exposure to wind. Thus the Forestry Commission estimates that planting an area of twenty thousand acres might employ ultimately six hundred persons when the forest is in full production.

Thus may be seen the potentialities of a hitherto neglected site of natural resources as affected by the march of science and engineering.

R. J. SARJANT

CHEMICAL INDUSTRY IN BRITAIN DURING 1953

SUPPLEMENTING the report on the chemical industry, 1949, published in February 1950, the Association of British Chemical Manufacturers has now issued a "Report on the Chemical Industry, 1953"*, based on replies received to a questionnaire addressed to its members early in 1953. The present report adopts the same definition of chemical industry as was used in the earlier one: "the manufacture of heavy chemicals, industrial gases, fertilisers, dyestuffs, medicinal and other fine chemicals, explosives, plastics and synthetic resins, but not the compounding of chemicals to make such products as paints, insecticides, sheep and cattle dips, and pharmaceutical preparations". On this basis the industry represents about one-third of the activities covered by the definition of chemicals and allied trades used by the Ministry of Labour and National Service for its statistics.

For 1952, returns were received from 234 of the 272 firms that previously reported for 1948, and these 234 firms employed capital of £406.8 million, compared with £230.6 million in 1948, the capital of the 38 firms which failed to reply totalling less than £6 million. The total staff employed in the industry increased from 141,817 to 151,349, the scientific staff rising from 6,176 to 7,406, or roughly 20 per cent, compared with the forecast of an increase of 40 per cent in respect of chemists, by 1953, in the earlier report. Employed capital per employee rose from £1,600 to nearly £2,700 at the end of 1952, when the expansion schemes in progress involved a total capital expenditure of £138 million, with additional schemes awaiting licences or under consideration to the total of £91 million. The expenditure of £11.2 million on research and development in 1952 approximates closely to the forecast of 32 per cent increase in 1948, but the number employed on research and development only rose by 8 per cent, from 10,100 to 10,914; in the same period the number of scientific workers so employed rose from 3,000 to 3,267. When the additional laboratories and other experimental facilities, for which capital expenditure of £6.2

million is in hand, are available, recurrent expenditure on research and development will rise to £12.7 million or almost 50 per cent above that in 1948.

New products are being added to the industry's selling range at the rate of several hundred every year, and production has increased by 29 per cent in volume, compared with 15 per cent for all manufacturing industries, with an estimated increase in value of 60 per cent. Productivity increased by 21 per cent on a volume basis and 51 per cent on a value basis, these figures being attributed to the increase in employed capital, the increasing use of instrumentation for process control and the application of work study methods. Nevertheless, it has not been possible, nor will it ever be, to eliminate imports; of the £49.68 million imported in 1952, £9.3 million consisted of potassium compounds and extracts for tanning, for which there is no available indigenous supply of raw materials. Drugs, medicines and medicinal preparations were imported to the amount of £4.54 million, cellulose acetate to £2.38 million, sodium compounds to £2.97 million, vinyl resins to £1.19 million and synthetic organic dyestuffs to £0.88 million. Exports were raised from £38.25 million in 1948 to £151.7 million in 1952 (£146 million in 1953) with indirect exports of chemicals estimated at £60 million in 1952, the United States of America (£11.07 million) and India (£10.9 million) being the largest markets. Exports to all dollar markets rose from £5.62 million in 1948 to £19.05 million in 1952.

The difficulties, referred to in the earlier report in the execution of the industry's expansion schemes still exist, though they are less serious. It is much easier to obtain the necessary authorization for a new project, and the sulphur position has been eased. The scarcity of scientific and technical staff still hampers the development of the industry and its efforts to increase productivity, and the rising costs of fuel and transport are seriously affecting the competitive position of the chemical industry and other branches of British industry in the export market. The report claims that there is every prospect that the industry will continue to hold its own and expand its exports, more particularly the specialities being developed by research. The industry is also confident of its ability both to meet the new requirements of Britain's consuming industries, with their changing technologies, and to provide for the changing demands in the overseas markets where industrialization is taking place.

RECENT ADVANCES IN THE CHEMISTRY AND BIOLOGY OF THE PTERIDINES

SYMPOSIUM IN LONDON

A SYMPOSIUM sponsored by the Ciba Foundation, the twenty-fifth of its kind, was held in London during March 22-25, bringing together for the second time chemists and biologists working in the pteridine field. The programme of the symposium gave equal weight to discussions upon the chemical and upon the biological aspects of pteridine research, the former being held under the chairmanship of Prof. A. Albert, of the Australian National

* Association of British Chemical Manufacturers. Report on the Chemical Industry, 1953; a Supplement to the 1949 Report. Pp. 12. (London: Association of British Chemical Manufacturers, 1954.) 1s.

University (Dept. of Medical Chemistry, 183 Euston Road, London, N.W.1), and the latter under that of Dr. W. Jacobson (Strangeways Research Laboratory, Cambridge).

In a series of three papers, Dr. E. C. Taylor, jun. (University of Illinois, Urbana), covered the work of his school upon the degradation and synthesis of the polysubstituted pteridines, and upon the elucidation of the structure of some pyrimido-pteridines. Pteridines substituted in both the 2- and the 4-positions by amino- or hydroxy-groups undergo ring opening on aminolysis to give 2-amino-3-carbamidopyrazines, compounds which, Dr. Taylor indicated, are of particular utility in the synthesis of pteridines with substituents in the pyrimidine ring different from those of the compound degraded. Another important intermediate is 2:4:6:7-tetrachloropteridine, which can be reduced to 2:4-dichloro-5:6:7:8-tetrahydropteridine and to 5:6:7:8-tetrahydropteridine, and which forms 2:4-dichloro-6:7-diaminopteridine and then tetra-aminopteridine on treatment with ammonia. Dealing with the 'bis-alloxazine' of Wieland, Dr. Taylor reported that degradative studies show it to be a pyrimido-(5:4:6:7)-pteridine, and that such compounds can be obtained generally by the reaction between a 4:5-diaminopyrimidine and alloxan in acid solution. Dr. G. H. Hitchings (Wellcome Research Laboratories, New York) described the preparation of two tetra-aminopyrimidopteridines by aeration of a solution of 2:4:5:6-tetra-aminopyrimidine. The predominant yellow isomer on deamination by nitrous acid gives 2:4:5:7-tetra-hydroxypyrimido-(5:4:6:7)-pteridine (Wieland's bis-alloxazine), the structure of which has been established by an unequivocal synthesis. Mr. G. M. Timmis (Chester Beatty Research Institute, London) gave an account of further condensed ring systems containing the pteridine nucleus, and of de-aza-pteridines and de-aza-purines, which have been obtained from the *ortho*-aminonitroso compounds of the benzene, naphthalene, pyridine and pyrimidine series.

Discussing the monosubstituted pteridines, of which some forty are now known, Dr. D. J. Brown (Australian National University, London) indicated that the study of these compounds has given information which is an important complement to that derived from the investigation of the natural and more complicated pteridines, while the simplicity of the compounds facilitates the study of the relationships between their structure and biological activities. In general, the monosubstituted pteridines can be divided into two classes: those substituted by hydrogen-bonding groups, and those containing groups which do not give rise to intermolecular binding. The compounds of the first class are soluble only in boiling water, are stable and possess high melting or decomposition points, while those of the second class are appreciably soluble in organic solvents, are relatively unstable and melt below 200° C.

Three unresolved problems encountered in the study of monosubstituted pteridines were discussed by Prof. Albert. The first concerns the anomalous base-weakening effect of a methyl-group placed in the 4- or the 7-position of the pteridine nucleus; the second has to do with the nature of the coloured products formed by treating 2-monosubstituted pteridines with mineral acid; and the third is the question of the structural forms of 6-hydroxypteridine involved in the slow tautomerism which is revealed

by titration with alkali followed by back-titration with acid.

Dr. H. C. S. Wood (Royal Technical College, Glasgow) reported that the alkylation of 4- and 7-hydroxypteridine leads to N-alkyl-pteridones, the constitution of which has been established by degradative studies followed by unambiguous syntheses. Similarly, 2:4-dihydroxypteridine gives 1:3-dimethyl-2:4-pteridone on treatment with methyl sulphate, but, as yet, the attempted alkylation of 2- and 6-hydroxypteridine has not been successful. The ultra-violet absorption spectra of the monosubstituted pteridines was discussed by Dr. S. F. Mason (Australian National University, London). Comparisons between the spectra of the hydroxy- and methoxy-pteridines and the available N-methylpteridones suggest that the hydroxypteridines normally exist in the pteridone form, while the spectra of the amino- and dimethylamino-pteridines indicate that the aminopteridines exist in the true amino form.

Dr. G. B. Elion (Wellcome Research Laboratories, New York) described the preparation and properties of 7-pteridones substituted in the 8-position with a hydroxyethyl-group, compounds which had been prepared because of the possibility that pteridines may occur in Nature as 8-substituted sugar derivatives, analogous to the purine nucleosides. The yellow pigment isolated from the *sepio* mutant of *Drosophila melanogaster*, which was discussed by Dr. H. S. Forrest (California Institute of Technology, Pasadena), may be an 8-substituted pteridine derivative. Degradative experiments have established that the major portion of the yellow pigment is 2-amino-4-hydroxy-6-carboxypteridine and that, with a fair degree of certainty, the remaining part is a lactyl group.

Prof. M. Polonovski (Faculty of Medicine, Paris) gave an account of the isolation of the pigments xanthopterin, leucopterin and isoxanthopterin, from the organs of various insects, such as *Gonopteryx* and *Bombix*, by means of chromatography. Dr. R. G. Busnel (Laboratory of Acoustic Physiology, Jouy-en-Josas) suggested that these pigments are the end-products of the catabolism of folic acid-like precursors, as they are always accompanied by mixtures of blue fluorescent substances akin to pteroylglutamic acid in the wing scales of the *Lepidoptera*. In the metabolically active cells of *Bombix mori*, pteridines of the isoxanthopterin type, notably fluoresceyanine, are found much more frequently than derivatives of the xanthopterin type; indeed, the presence of fluoresceyanine has been demonstrated, by electrophoresis and chromatography, in the ovule and the egg of the insect, and in the chrysalis at successive stages of histolysis, histogenesis and immediately after eclosion. The fluoresceyanine isolated by Prof. Polonovski and Dr. Busnel was shown by Dr. F. Korte (State Chemical Institute, Hamburg) to be a mixture of isoxanthopterin and a small amount of a substance believed, on degradative evidence, to be 2-amino-4:7-dihydroxy-6-(α : β -dihydroxyethyl)pteridine. However, synthesis of the compound of this structure showed complete lack of identity with the minor constituent of fluoresceyanine. Attempts to elucidate the constitution of urothione, a sulphur-containing pteridine isolated from urine, were described by Prof. R. Tschesche (State Chemical Institute, Hamburg). The present evidence of degradative and synthetic experiments, together with spectral data, suggest that urothione consists

of a dihydrothienyl-(2:3:6:7)-pteridine nucleus substituted in the dihydrothiophen ring with a glycol and a methylthio-group, and in the pteridine ring with a 2-amino- and a 4-hydroxy-group.

Dr. D. B. Cosulich (American Cyanamid Co., New Jersey) gave an account of the synthesis of a series of 2-sulphonamido-4-hydroxypteridines, compounds which had been prepared with the view of combining the biological activities of the pteridines and the sulphonamides. Neither these compounds, nor a series of pteric acid analogues in which the benzoic acid group had been replaced by benzenesulphonamide groupings, displayed important biological activity. The 2:4-diaminopteridines, substituted in the 6- and 7-positions with alkyl or aryl groups, were reported by Dr. H. O. J. Collier (Allen and Hanburys, Ltd., Herts) to antagonize citrovorum factor and to do so competitively over a limited range of concentrations. It was suggested that this property is the basis of the other biological actions of the 2:4-diaminopteridines, namely, the antagonism of pteroylglutamic acid, synergism with sulphonamides, inhibition of the growth of *Streptococcus* and other micro-organisms in culture, suppression of infections of these organisms in laboratory animals, and cross-resistance with proguanil and pyrimethamine. However, Dr. Hitchings pointed out that in lactobacilli 2:4-diaminopyrimidines and condensed systems containing the 2:4-diaminopyrimidine moiety (including 2:4-diaminopteridines) inhibit growth by interfering with an earlier stage, namely, the conversion of pteroylglutamic acid into the citrovorum factor. Antithymines and antipurines, such as 6-bromouracil and 8-azaguanine, respectively, markedly potentiate the antifolate acid activities of these compounds, suggesting that the latter interfere also with the synthesis of thymine and purines. Dr. D. J. Hutchison (Memorial Center for Cancer and Allied Diseases, New York) reported that the formation of citrovorum factor from pteroylglutamic acid is inhibited in *Streptococcus* by amethopterin, and that a mutant strain has been produced which is resistant to such antagonists. The growth of the mutant strain is greatly stimulated by natural purines and is inhibited by 6-mercaptopurine, a compound effecting a metabolic interference different from that of the folic acid antagonists.

Discussing the metabolic relationships between *p*-aminobenzoic acid and folic acid in micro-organisms, Dr. D. D. Woods (Biochemistry Department, Oxford) indicated that folic acid does not render all organisms insensitive to sulphonamides, nor does it invariably replace *p*-aminobenzoic acid in promoting the growth of organisms requiring the latter. Thus it is possible that none of the established forms of folic acid is a direct intermediate on the metabolic pathway from *p*-aminobenzoic acid to coenzyme F, and that some organisms are able to convert known forms to intermediates on this pathway, while others can do so only at a low efficiency or not at all. Dr. R. H. Nimmo-Smith (Biochemistry Department, Oxford) discussed the function of folic acid in the biosynthesis of purine derivatives, suggesting that folic acid is involved in the introduction of the C₈ and perhaps the C₆ atom of the purine skeleton. The suggestion was based upon the observations that the riboside of 4-amino-5-carboxamidoimidazole accumulates under conditions where the microbiological synthesis of folic acid is deficient, and that purines have a 'sparing' effect upon the concentration of folic acid needed to support the full growth of micro-organisms requiring

this factor. Moreover, the free carboxamide supports the growth of a variety of micro-organisms possessing a nutritional requirement for purines, while labelled carboxamide gives rise to labelled adenine and other purines in both micro-organisms and mammals. In discussion, Dr. Hitchings described Greenberg's recent work which shows that folic acid with carbon-14 in the formyl group, when converted into an active form by pigeon liver or by adenosine triphosphate, quantitatively transferred the radioactive carbon to the 2-position of the purine skeleton, even in the presence of excess non-labelled formate.

Dr. M. Webb (Strangeways Research Laboratory, Cambridge) reported that folic acid antagonists retard the growth of micro-organisms and give rise to populations composed of filamentous cells which are depleted of deoxyribonucleic acid. The addition of thymine with the antagonist to the growth medium prevents the formation of filamentous cells and restores the cell deoxyribonucleic acid level to normal. It seems, therefore, that folic acid antagonists decrease the rate of deoxyribonucleic acid synthesis in micro-organisms, and so inhibit the division of nuclear material and the division of the cell. Dr. G. W. Kidder (Amherst College, Massachusetts) gave an account of the effect of folic acid analogues upon the growth of *Tetrahymena*, a ciliated protozoan possessing an absolute dietary requirement for folic acid. The multiplication of this organism is inhibited by folic acid analogues in which substitutions have been made on the ring systems, the inhibition of growth being reversed by folic acid, but not by any combination of purines and pyrimidines. The organism cannot utilize folic acid analogues in which the glutamic acid residue has been replaced by another amino-acid, indicating that it cannot hydrolyse the bond between the *p*-aminobenzoic acid portion of the molecule and the amino-acid residue.

Dr. W. Jacobson described the accumulation of cells at the metaphase stage of division in the bone marrow of leukemic patients or leukemic mice treated with folic acid antagonists. The inhibition of cell division is reversed by the citrovorum factor, but not by pteroylglutamic acid, demonstrating that the cells cannot utilize or convert pteroylglutamic acid itself. Accordingly, it seems that folic acid antagonists replace the citrovorum factor within the dividing cells, and that the citrovorum factor performs a vitally important function during the few minutes of the transition from the metaphase to anaphase stages of mitosis. Similar biological effects of the folic acid antagonists were reported by Dr. R. Bellairs (University College, London) with reference to the embryonic development of the chick. The treatment of chick embryos with aminopterin or amethopterin during gastrulation brings about a clumping of the chromosomes at the metaphase stage of cell division, and leads to a retarded, abnormal growth which is manifest notably in a failure of the neural plate to close dorsally and of the foregut floor to close off ventrally. Normal embryogeny is observed when the citrovorum factor is injected simultaneously with the folic acid antagonist, but not when pteroylglutamic acid is injected with the antagonist.

Prof. A. Haddow (Chester Beatty Research Institute, London) reported that xanthopterin brings about a marked increase in the size of the kidney of the rat, an increase caused by a greatly increased rate of mitosis leading to excessive but perfectly normal cell-division in the kidney tubules. Dr.

Jacobson described a yellow pigment, isolated from the argentaffine cells of the mammalian intestinal mucosa, which possesses a fluorescence spectrum strikingly similar to that of xanthopterin in regard to both the position and the intensity of the bands. Accordingly, it is of some interest that the argentaffine cells have been found to be much reduced in number in certain types of megaloblastic anemias. Comparing the incidence of megaloblastic anemia in India and Britain, Dr. R. H. Girdwood (Medical Department, University of Edinburgh) related the higher incidence of the disease in India to the lower folic acid content of the average Indian diet. However, the relation between the disease and folic acid deficiency is not a simple one, for it is possible to have cases of megaloblastic anemia associated with intestinal malabsorption of folic acid, without vitamin B₁₂ depletion, and yet have a normal excretion of folic acid after the injection of a test dose of pteroylglutamic acid. With reference to this problem, Dr. E. M. Coates (National Institute for Research in Dairying, Reading) reported that vitamin B₁₂ does not alleviate folic acid deficiency in chicks, nor does folic acid reduce the vitamin B₁₂ requirements of the chick.

Dr. J. Colsky (Maimonides Hospital of Brooklyn, New York) gave an account of the case histories of several leukemic patients treated with folic acid antagonists. Continuous treatment with the antagonists over a period of months was accompanied, in five out of six cases, by a disturbance of the liver functions, which resulted ultimately in severe fibrosis of the liver. Dr. Colsky suggested that the production of a folic acid deficient state by means of the antagonists may cause injury to the liver by interference with the normal metabolism of choline, methionine and betaine.

In opening the symposium, Prof. Albert paid a tribute to the discoverer of the natural pteridines, Gowland Hopkins, whose work was also appraised by Dr. Jacobson at the end of the final session in a general review of the progress achieved in the pteridine field. At the close of the symposium the members expressed their appreciation of the work of the director of the Ciba Foundation, Dr. G. E. W. Wolstenholme, and of his staff, who, by their efficient organization, had materially contributed to the success of the conference. S. F. MASON

PLEISTOCENE GEOLOGY OF BRITAIN

DATA of a novel and curious kind provide, in the words of Mr. R. G. Carruthers, an interpretation of the British boulder clay deposits which differs radically from that hitherto current. The 'orthodox' scheme, with its multiglaciation and interglacials, is disregarded altogether in a booklet entitled "Glacial Drifts and the Undermelt Theory". Instead, all the British tills and many of the accompanying glacial-fluvial deposits are explained as an "undermelt" product of one great glaciation, and "changes of some moment are suggested in the conventional North European scheme, which brings a long-sought harmony into its relations with the Alps on one hand and Britain on the other".

This contribution of Carruthers to Pleistocene geology is remarkable in several respects. Not only does it do away with the views developed by other

authors and proposes a new scheme of correlation between northern France, the Thames, East Anglia, Denmark, north Germany and the Alps, but also it raises a serious question of scientific method, which deserves to be noted here.

Relying on certain observations of the effects of subglacial melting, the author develops his 'undermelt theory'. Subglacial melting and shear-structures have for many years been known from the Scandinavian area of glaciation, though Carruthers was probably the first to note some of them in Britain. Moreover, he undertook to explain many other observations by means of this same phenomenon¹, and he eventually convinced himself that the various sheets of moraine in Great Britain all belong to the same glaciation. In doing so, he applied the interpretation he gave to a small set of observations to a very wide field (now including the whole of the formerly glaciated part of Britain) and he was happy to find that the sequence of Pleistocene deposits appeared much simpler if monoglaciation was adopted. Multiglaciation is attacked by saying that in Britain the sequence can be interpreted monoglacially. With this most workers in the field of Pleistocene geology are compelled to disagree, for reasons that are not mentioned by Carruthers and, judging from the list of references, were perhaps not known to him.

But granting that this 'undermelt theory' is possible, there remains to be assessed its degree of probability. This Carruthers does not do. The new 'possible' interpretation of the sequence of tills is, without any discussion of the conclusions of earlier authors, regarded as probable, nay, even as the only sound one. In regarding the possible as probable, Carruthers does not stand alone. It is a tendency of many scientific writers, which must be regarded as decidedly harmful. The valuable work of earlier authors which led to different conclusions is not refuted, but simply remains unconsidered, and the new theory can thus be made to appear in a spotless garb. Readers who are not themselves experts in the field will thus be misled into believing that the theory proposed is the only one worthy of consideration. From the point of view of scientific method this is a deplorable way of presenting scientific interpretations; scientists should discuss in their publications the reasons for considering their own hypothesis or theory more probable than others previously put forward.

When Carruthers undertakes to fit his British monoglaciation in with the Continental chronology, he finds "at long last, . . . re-advances and interglacial periods proved beyond a shadow of doubt". It appears that it did not occur to him that this multiglaciation of the countries from France to Denmark, the nearest neighbours of Britain, renders his British monoglaciation improbable. He goes to some length in determining the age of the Eem Sea. This effort is considerably out of date, the latest publication quoted being more than twenty years old, while several treatises in English, French and German are available from which the necessary information might have been obtained². A chronological scheme is thus developed which only the uninitiated might be prepared to consider. The four glaciations (Elster, Saale, Warthe, Weichsel) are considered separated by three interglacials, the first being represented by the Holstein clays, the middle interglacial by the Eem, and the last interglacial by the *Brassia* Beds. While the Holstein Sea is now generally placed between Elster and Saale, it is the

General nomenclature	Sea-levels	Loess of North France	Loess of Mainz Basin	Alps Moraines	North Germany
Early glaciation				"Donau" glaciation of Eberl and others	
Ante-pennultimate Interglacial	a. 60 m.	Achenheim Gravels Porto du Bois (Somme) Sollfussion		Weathering and erosion Gunz with 3 phases	? Earliest tills
Ante-pennultimate Glaciation				Weathering and erosion	
Pennultimate Interglacial	a. 35 m.	Middle Terrace St. Acheul Loess Achenheim (part)	Older Loess	Mindel with 2 or 3 phases	Elster
Pennultimate Glaciation	a. - 200 m.			Weathering and erosion Riss	Holstein Sea
Last Interglacial	{ Temperate Cool Temperate Main Monastirian + 18 m. Lower Late Monastirian + 7-8 m.	} "Argile Rouge" Loess Recent I Brown-earth	Chernozem	Last Interglacial	{ Last Interglacial with Eem transgression ? Warthe Fully temperate phase Weichsel
Last Glaciation 1	a. - 100 m.	Loess Recent I	Younger Loess I	Jungries	
Last Glaciation 1/2	Epi-Monastirian + 3 m.	Brown-earth	Brown-earth (thick)	Temperate phase	
Last Glaciation 2	a. - 70 m.	Loess Recent II	Younger Loess II	Young End Moraines Group I	
Last Glaciation 2/3	a. - 10 m.	Traces of brown-earth	Brown-earth (thin)	Very weak weathering	Climate cool
Last Glaciation 3	a. - 30 m.	Loess Recent III (Rhine Valley only)	Younger Loess III	Young End Moraines Group II	Late Weichsel stages
Post-glacial	Flandrian	Brown-earth	Chernozem degraded	Retreat of ice with altered oscillation	Retreat, with altered oscillation

second interglacial of the Pleistocene on this count, the first being represented by very few sites on the fringe of the Scandinavian glaciation area. The Eem phase belongs to the last interglacial in the climatic sense and is placed by Woldstedt, the foremost authority on Germany, between Warthe and Weichsel. (This is the Last Interglacial in Woldstedt's chronology, since he now regards Warthe as an after-phase of Saale. The uncertain position of the Warthe phase, however, need not obscure the larger issue.) Moreover, that new, cold-loving animals like the woolly rhinoceros and the mammoth should have appeared during the Last Interglacial is flatly contradicted by the evidence, and the flora which, apart from *Brassica*, included the walnut and *Thuja* in Central Europe, is definitely warm.

Carruthers holds that "once established, the application of this scheme to the Alps on the one hand and to Britain on the other presents no difficulty; all goes smoothly from the start". Again, the smoothness is the inevitable result of the neglect of other workers' labours. Calling Elster the First Glaciation of the Scandinavian sheet (which according to several workers it was not), it is equated with Alpine Gunz, and Saale with Alpine Mindel. This suggestion will find no followers in either North Germany or the Alps, for reasons which have been amply published. The correlation of Saale with Riss of the Alps is regarded as sound by all who have worked on this problem in the field.

Moreover, the lengths and temperatures of the interglacials were not as Carruthers considers them to have been. According to him, "both the First and Last Interglacial, while having their warm spells, were predominantly cold periods; the middle one was warm, more so even than today, and only at the close did it turn cool". While the second half of this statement agrees with the evidence in a broad sense, the First and Last Interglacial cannot be called

predominantly cold periods. That is amply shown by their faunas, which comprise frost-sensitive elements like hippopotamus and the macaque in Western Europe, but above all by the fossil soils of the European loess belt. It is impossible in this brief discussion to present the evidence in full. The Last Interglacial, for example, was warm enough in northern France to lead to the formation of sub-Mediterranean brown-earths. Correspondingly, there were large islands of chernozem in the Mainz basin, south of the Hartz Mountains and in Bohemia, Moravia and Lower Austria. At the same time, the *Strombus* fauna indicates warmer conditions in the Mediterranean and the Eem fauna similar conditions in the Atlantic.

A further complication adds to the difficulties in Carruthers's scheme. The glaciations were not simple cold periods but groups of phases separated by short interstadials, during which the climate quite often became temperate again. Similarly, the interglacials were interrupted by cool phases. The existence of such minor phases is universally accepted on the Continent, and they cannot be disregarded in attempts at correlation. The picture that has emerged for the Last Glaciation, and which was discussed at great length at the congress last year of the International Association on Quaternary Research (INQUA) in Rome and Pisa, and afterwards at the meeting of the German section in Stuttgart, is shown in the accompanying table.

There was general agreement that between phases here called Last Glaciation 1 and Last Glaciation 2, there intervened an interstadial with fully temperate conditions, so that Last Glaciation 1 can, if one likes, be regarded as an independent glaciation. No general agreement has been reached yet, however, about nomenclature. The system used by me is a general one, and it applies in particular to the loess belt. In the Alpine foreland, the geological surveys have

called Last Glaciation 1 "Jungries", while the same phase is the Würm 1 of Soergel of thirty years ago. In north Germany, it is conceivable that the independent position of Warthe may lead to its correlation with this "Jungries", with an interstadial of interglacial character following and the Last Interglacial (with the Monastirian sea-levels of 18 and 7.5 m.) preceding. That this long interstadial was actually as warm as a full interglacial is confirmed by its independent fossil shore-line, which lies at about 5 m.⁷

The picture of fluctuations of the climate during the Pleistocene, therefore, is of great complexity, and many years will pass before the sequences found even in European countries can be correlated in detail. But no correlation can afford to neglect the minor oscillations established in so many localities, and one is glad to notice that to the expert it becomes increasingly difficult to mistake one of the major interglacials for another.

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RANGE-ENERGY RELATION IN NUCLEAR TRACK EMULSIONS FOR PROTONS OF ENERGY UP TO 21 MeV.

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PHOTOGRAPHIC emulsions are being used to an increasing extent for accurate measurements in nuclear physics. It is therefore important that the relation between the energy of a particle and its range in an emulsion of specified moisture content should be known precisely over as wide an interval of energies as possible.

The first range-energy relation for concentrated emulsions was given in 1947 by Lattes, Fowler and Cser¹ for protons of energy up to 13 MeV. Many measurements have since been made, however, and it has been realized that atmospheric conditions can affect the amount of moisture in the emulsion, hence varying the stopping-power. It has become usual to quote the range-energy relation for dry emulsion,

the term 'dry' indicating not that water was entirely absent, but that the emulsion has been kept under vacuum for long enough for its moisture content to approach a constant value. According to the information supplied by Ilford Ltd., this value is about 0.06 gm. of water per c.c. of emulsion; this gives an emulsion of density about 3.04 gm./c.c. Rotblat² has given a relation for dry emulsion for proton energies up to 15 MeV., Catala and Gibbon³ for energies up to 16 MeV., and Bradner, Smith, Barkas and Bishop⁴ for energies up to 40 MeV. The last, however, do not claim great accuracy because of incomplete control of the moisture content.

The present results have been obtained from a series of measurements on two groups of protons from each of the reactions $^{16}\text{O}(d,p)^{17}\text{O}$ and $^{12}\text{C}(d,p)^{13}\text{C}$. The reactions took place in oxygen and acetylene gas, respectively, through which passed the 19-MeV. deuteron beam from the University of Birmingham cyclotron; the products emitted at angles between 15° and 165° were allowed to enter photographic emulsions held in a camera described by Burrows, Powell and Rotblat⁵. Before exposure, the plates (Ilford O2) were dried by evacuation in the presence of phosphorus pentoxide, for a minimum period of 12 hr. in the case of emulsions 400 microns thick, or 6 hr. with emulsions 200 microns thick. They were then transferred rapidly to the scattering camera, which also contained phosphorus pentoxide; the camera was evacuated for a further period before being filled with the appropriate pure dry gas.

RANGE-ENERGY RELATION FOR PROTONS IN ILFORD O2 EMULSION

Range (microns)	Energy (MeV.)	Range (microns)	Energy (MeV.)	Range (microns)	Energy (MeV.)
40	2.01	720	11.72	1,400	17.80
80	3.18	760	12.10	1,440	17.59
120	4.01	800	12.47	1,480	17.88
160	4.79	840	12.83	1,520	18.16
200	5.48	880	13.18	1,560	18.44
240	6.13	920	13.53	1,600	18.71
280	6.72	960	13.87	1,640	18.98
320	7.28	1,000	14.21	1,680	19.25
360	7.82	1,040	14.54	1,720	19.52
400	8.33	1,080	14.86	1,760	19.79
440	8.80	1,120	15.18	1,800	20.06
480	9.25	1,160	15.50	1,840	20.31
520	9.69	1,200	15.81	1,880	20.57
560	10.13	1,240	16.12	1,920	20.82
600	10.54	1,280	16.42	1,960	21.07
640	10.94	1,320	16.72	2,000	21.32
680	11.34	1,360	17.01		

The ranges were obtained by microscopic examination of the plates; small corrections were made for the effect of the gas traversed before the emulsion was reached, and for the foreshortening of the tracks resulting from the fact that the particles entered the emulsions at angles of a few degrees. The precision of range measurements on individual tracks was ± 2 microns. Multiple scattering causes slight changes in the angle of dip along the length of each track, but it is not usual to make any allowance for the effect of this on the observed range. The average magnitude of the effect has been considered elsewhere⁶.

The energies were obtained from the known Q-values of the reactions, the angles of emission, and the energy of the incident deuterons. The Q-values used⁷ were 1.918 and 1.045 MeV. for $^{16}\text{O}(d,p)^{17}\text{O}$ and 2.723 and -0.363 MeV. for $^{12}\text{C}(d,p)^{13}\text{C}$. The angles of emission were known accurately from the map of fiducial points⁸ giving the co-ordinates of the area scanned on the plate. The energy of the incident

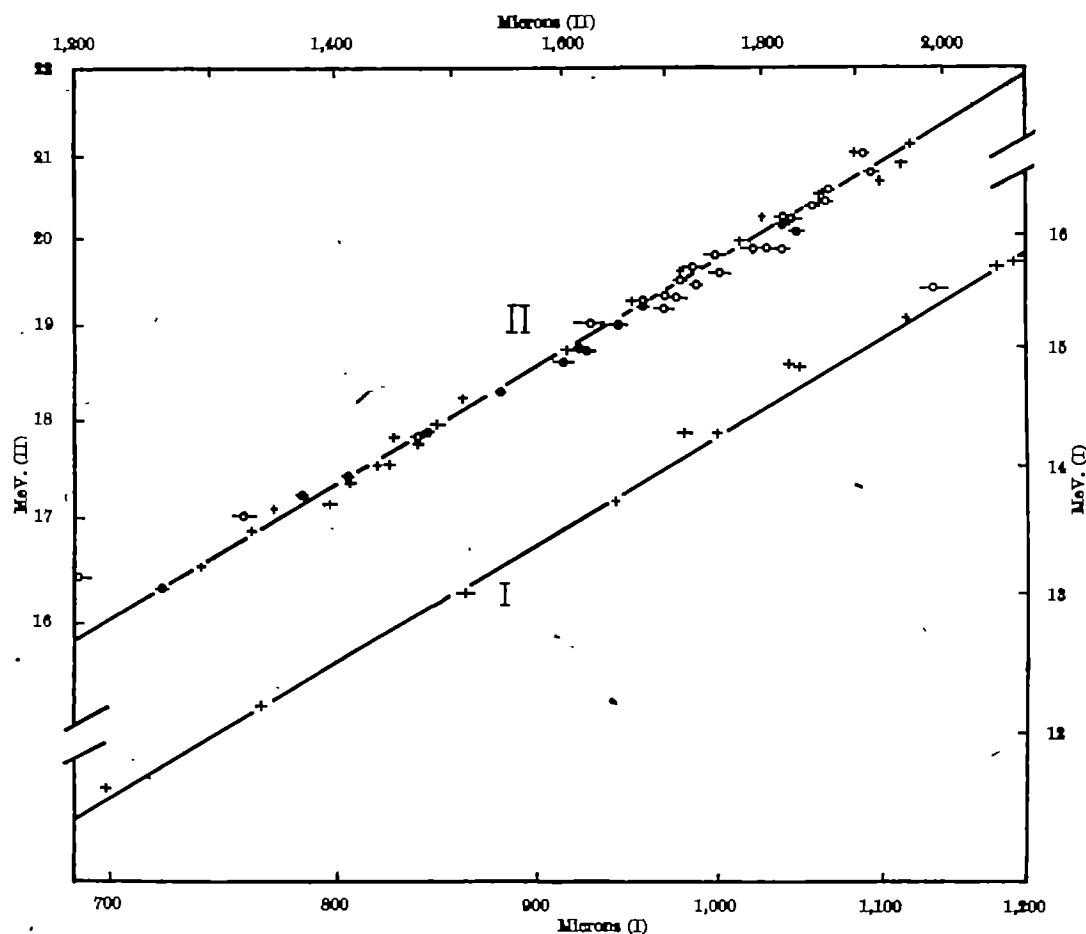


Fig. 1. Logarithmic plot of range-energy relation: $\circ$ —, results from the reaction $^{14}\text{O}(\text{d}, \text{p})^{15}\text{O}$; $+$ —, results from the reaction $^{14}\text{O}(\text{d}, \text{p})^{15}\text{O}$. The horizontal lines give an indication of the uncertainty in range resulting from straggling. The straight line represents the relation $E = 0.2487 R^{2.544}$.

deuterons was found from the range of the elastically scattered deuterons, with the aid of the range-energy relation of Rotblat³. Most of the deuteron energies measured were of the order of 16 MeV., and the range of a 16-MeV. deuteron is twice that of an 8-MeV. proton. The present results are therefore based on Rotblat's figures in the region of 8 MeV.; since this part of the range-energy relation is known extremely accurately, there can be little uncertainty in the results.

A least-squares method was used to find the simple power law which fitted best to the new results and also to the figures given by Rotblat for energies greater than 7 MeV. All the groups of measurements were found to be mutually consistent, the mean deviation of the seventy individual measurements from the best curve being 0.6 per cent in energy. Over the limited region between 10 MeV. and 21 MeV., the range-energy relation can be represented by the formula

$$E = 0.2487 R^{2.544},$$

E being measured in MeV. and R in microns; there is no evidence for a departure from this relation greater than the experimental error. At lower energies we assume the almost identical results of Rotblat, and Catala and Gibson, to be correct.

The results are shown in Fig. 1, but for the convenience of readers the final relation from zero to

21 MeV. is given in the form of a table. The probable accuracy of the energies is about 0.3 per cent. For ranges greater than 800 microns the energy values are about 0.5 per cent greater than those given by Rotblat and by Catala and Gibson, and they are more than 1 per cent greater than those given by Bradner *et al.*⁴. There is good agreement with the results of Panofsky and Fillmore⁵ in the region of 700 microns. Agreement with the theoretical curve obtained by Vigneron⁶ is, however, not very good.

We wish to thank Profs. C. F. Powell and W. E. Burcham for their interest and assistance, Mrs. B. M. Herman, Miss S. Dennison and Miss J. Holmes for much of the microscope work, Mr. R. G. Freemantle and the staff of the Birmingham cyclotron for helping in the exposures, and the Nuffield Foundation and the Department of Scientific and Industrial Research for financial assistance. [March 24.]

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LETTERS TO THE EDITORS

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A Method for the Measurement of the Distance of Radio Stars

THE existence of a large number of discrete sources of extraterrestrial radio radiation (radio stars) has now been established. For the majority of the sources there is no information about their distance; only a few have been identified with celestial objects observed photographically. Attempts to measure the radio parallax of the sources have been made by Ryle¹, Mills and Thomas² and Smith³. These experiments failed to measure any parallax and could only establish that the radio stars were at a distance greater than $\frac{1}{2}$ parsec. The present communication describes a new method for the measurement of the distance of radio stars in the Galaxy, and gives preliminary results for the two intense sources in Cygnus and Cassiopeia.

The method depends upon the absorption of the radiation from the radio stars by interstellar hydrogen at a frequency of about 1,420 Mc./s., corresponding to the spectral line of the ground-state of the neutral hydrogen atom⁴. If the radiation from the source traverses neutral hydrogen in the Galaxy, it will suffer absorption at the line frequency, whereas its emission at neighbouring frequencies will be unaffected. The method assumes that the spectrum of the radio star is continuous, and does not show line structure at this frequency. The spatial distribution of the neutral hydrogen⁵ can be obtained from a knowledge of its 21-cm. emission line profile using Oort's⁶ model of the Galaxy, since the precise emission frequency of the neutral hydrogen depends upon the velocity of the gas relative to the observer, which in turn depends upon its distance from the sun. Thus from observations of the spectral distribution and the magnitude of the absorption, the distance of the radio star can be estimated.

The shape of the profile of the hydrogen emission line in the direction of the radio stars in Cygnus and Cassiopeia has been measured using a radio spectrometer in conjunction with an aerial of 1.5° beam-width. These profiles are shown in Fig. 1. The complex shape of the line profile arises from Doppler effects introduced by differential galactic rotation. The frequency scale has been calibrated in terms of distance by using Oort's model of the Galaxy. The peaks in the line profiles correspond to spiral arms in the Galaxy and agree with the distribution of gas in the galactic plane given by Oort and Muller as illustrated in Fig. 2. In the Cygnus region the undisplaced peak in the profile is associated with the hydrogen in a spiral arm which is at approximately

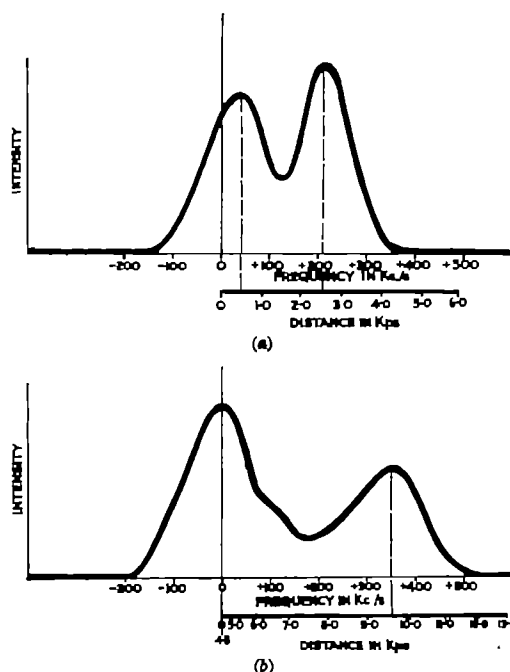


Fig. 1. Intensity-frequency scans of the (a) Cassiopeia and (b) Cygnus regions of the Galaxy. The intensity is given in arbitrary units which are the same for both profiles

the same distance as the sun from the galactic centre. In this case the direction of the radio star lies along a spiral arm for a distance of 4,500 parsecs. The second peak corresponds to emission from an outer arm at a distance of 9,500 parsecs from the sun. In the direction of Cassiopeia, the gas in the nearer arm is at 500 parsecs, and that in the outer arm is at 2,500 parsecs from the sun.

The intensity of the Cygnus and Cassiopeia sources has been measured at two frequencies corresponding to the two peaks of the line profiles shown in Fig. 1. The intensity of the radiation in the absence of absorption has been established by measuring the mean intensity observed at two frequencies displaced $\pm \frac{1}{2}$ Mc./s. from the frequency of the peaks in Fig. 1. The actual absorption is then obtained from these measurements, as shown in Table 1. In order to establish the distance of the radio stars from these results, it is necessary to know the total absorption which would be suffered by the 21-cm. radiation if it completely traversed the gas in the spiral arms in the directions indicated in Fig. 2. This has been calculated by comparing the measured intensity of the emission line in the direction of the galactic anti-centre with that observed from the spiral arms in the direction of the radio stars. The values are given in Table 1. It has been assumed that the gas in the direction of the

Table 1

Radio source		First peak (nearer arm)			Second peak (outer arm)			
Galactic longitude	Galactic latitude	Distance of gas (parsecs)	Total absorption*	Observed absorption ratio†	Distance of gas (parsecs)	Total absorption*	Observed absorption ratio†	
Cygnus	44.0°	+ 4.6°	0-4,500	0.5	0.62 ± 0.06	9,500	0.3	0.28 ± 0.18
Cassiopeia	79.5°	- 1.9°	500	0.5	0.30 ± 0.06	2,500	0.6	0.16 ± 0.10

* The total absorption is that expected for complete traversal of the spiral arm.

† The observed absorption ratio is defined as $\frac{I_b - I_a}{I_b}$, where I_a is intensity on the hydrogen-line frequency, and I_b is intensity $\pm \frac{1}{2}$ Mc./s. from the hydrogen-line frequency.

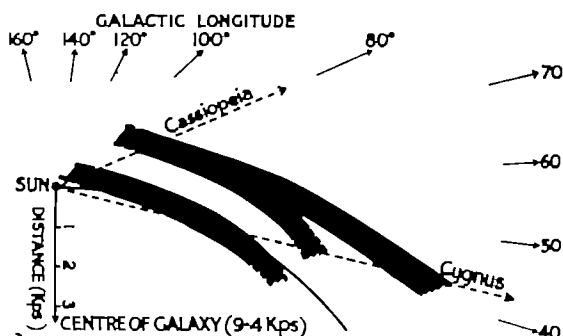


Fig. 2. A schematic diagram of the distribution of neutral hydrogen in the general direction of Cygnus and Cassiopeia. Full line through the sun is locus of points the same distance from the galactic centre as the sun.

galactic centre is completely opaque at the frequency of the emission line, in accord with the results of Oort.

The results in Table 1 show that the radiation from the Cygnus source is absorbed in both arms of the Galaxy; the observed absorption is of the order of that expected for the two arms. The distance of the source is therefore greater than 9,500 parsecs. Minkowski¹ has identified the Cygnus source as extragalactic and has associated it with two galaxies in collision at a distance of 34 megaparsecs. The present result is therefore consistent with this identification.

In the case of the Cassiopeia source, the absorption is very much less than that which would be expected if the radiation traversed the spiral arms—a result which indicates that the source lies within the Galaxy. However, the results are not sufficiently accurate to establish with certainty whether the source lies within the first spiral arm or in the region between the first and second arms. The relatively greater amount of absorption observed in the first peak suggests that the source lies within the first spiral arm. The present result, therefore, establishes that the distance of the source is not greater than 2,500 parsecs and that it probably lies between 500 and 2,500 parsecs. It can be anticipated that more accurate measurements of the absorption spectrum will reduce this uncertainty. Much interest has been focused on the distance of the Cassiopeia source; Minkowski¹ has suggested that it may be 300 or 500 parsecs, so that the tentative results suggested here are not incompatible with his estimate. The technique of measurement is now being refined in order to extend the measurements to other radio stars.

We wish to thank Dr. C. G. Little for suggesting the method and Prof. A. C. B. Lovell and Mr. R. Hanbury Brown for their interest and help. One of us (D. R. W. W.) is indebted to the Department of Scientific and Industrial Research for a maintenance grant.

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Rock Magnetism and Polar Wandering

It is now generally accepted that lava flows become permanently magnetized in the direction of the local geomagnetic field when they cool down through their Curie point¹. Similarly, most sediments, on deposition, acquire a weak magnetic polarization². This magnetization is thought to be due to lining-up of the minute permanently magnetized particles of the ferromagnetic minerals as they sink to the bottom. If used with caution, studies of rock magnetism may therefore yield valuable data concerning the direction of the geomagnetic field in the past.

Several studies are available of the direction of magnetization of comparatively recent igneous and sedimentary rocks (lava flows and varved clays). They are shown in Table 1. These data have been used for calculating a mean direction of magnetization and Fisher's³ radius of the circle of confidence (θ) for $P = 5$ per cent. This mean direction has been compared with the direction of the (theoretical) dipole field and the angular difference determined; these figures are also shown in Table 1. The dipole field is the field due to a geocentric axial dipole; its declination is zero, its inclination (I) is calculated from the formula

$$\tan I = 2 \tan \lambda,$$

when λ is the geographical latitude of the locality.

Table 1. MEAN DIRECTIONS OF THE NATURAL PERMANENT MAGNETIZATION OF COMPARATIVELY RECENT IGNEOUS AND SEDIMENTARY ROCKS

Description	Period covered, in years	Mean direction of magnetization		Fisher's θ for $P = 0.05$	Angle with dipole field
		Declination	Inclination		
Historical lava flows of Mount Etna ⁴	2,800	N. 4.3° E.	+55.8°	2.0°	1.3°
Postglacial lava flows of S.W. Iceland ⁴	4,000	N. 1.1° E.	+73.8°	8.2°	2.5°
Varved clays of the U.S.A. ⁵	6,000	N. 4.5° W.	+51.4°	10.0°	10.0°
Varved clays of Sweden ⁶	1,000	N. 2.6° W.	+73.4°	8.8°	2.4°

The magnetic stability of these rocks can be demonstrated.

Table 1 shows that for the Etna flows, θ for $P = 5$ per cent amounts to 2.0°. This means that the probability is only 5 per cent that the true mean direction of magnetization will deviate by more than 2.0° from the calculated mean direction. We note that the dipole field direction deviates by only 1.3° from the calculated mean direction. A similar situation is encountered for the three other groups in Table 1. In none of these cases does the angle between the mean direction of magnetization and the dipole field direction exceed θ for $P = 5$ per cent. The conclusion is therefore drawn that in recent geological times, and taken over a period of several thousand years, the magnetic poles have centred on the geographic poles.

Assuming that the same conclusion holds for the geological past, we may draw conclusions concerning the position of the geographic poles in the past from the mean directions of magnetization of groups of older rocks. These mean directions for some groups are shown in Table 2. Also are shown Fisher's θ for $P = 0.05$ and the angle between the mean direction and the present theoretical dipole field (that is, the field due to a geocentric dipole directed along the present geographical axis).

Table 2. MEAN DIRECTIONS OF THE NATURAL PERMANENT MAGNETIZATION OF TERTIARY AND QUATERNARY IGNEOUS ROCKS

Age	Country	Mean direction of magnetization		Fisher's θ for $P=0.05$	Angle with present dipole field
		Declination	Inclination		
Early Quaternary	Iceland ⁴	N. 10° E.	+75°	6.9°	15°
Pliocene	France ⁴	N. 17-0° E.	+62-6°	12.5°	8.0°
Pleistocene	France ⁴	N. 3-3° W.	+51.1°	14.0°	12.8°
Miocene	Iceland ⁴	N. 1-5° E.	+77-8°	5.5°	0.8°
Pliocene	France ⁴	N. 5-5° W.	+73-3°	15-6°	3.1°
Miocene	England ⁵	N. 21.1° E.	+57-2°	10.8°	11-9°
Oligocene	France ⁶	N. 43.1° W.	+78.1°	23.7°	12-5°
Oligocene	Scotland ¹¹	N. 14-0° E.	+60.2°	5.4°	11.5°
Eocene	Ireland ¹²				

For all these groups the magnetic stability can be demonstrated; for most it follows from the fact that they are reversely magnetized. For our purpose it is irrelevant whether this reverse magnetization is due to a reversal of the main geomagnetic field or to a self-reversing mineral or combination of minerals in the rock^{4,12}. Where necessary, the opposite of the mean direction has, therefore, been recorded in Table 2.

Table 2 shows that, except in two cases, θ for $P = 5$ per cent exceeds the angular difference between the calculated mean direction and the present dipole field. For the Oligocene data from France, the difference between θ and the above-mentioned angular difference is so small that little can be proved either way. However, for the Eocene lava flows of Northern Ireland there can be no doubt that the mean direction of magnetization is significantly different from the present dipole field direction.

These results are more easily discussed when represented graphically. This will not be done here; but the procedure followed may be summarized briefly. The mean direction of magnetization with its circle of confidence is plotted on a stereographic projection. Several points on this circle are selected and considered as dipole field directions due to a non-axial geocentric dipole. The corresponding position of the magnetic poles can be easily calculated and consequently a locus can be constructed on the earth's surface, which corresponds to the circle of confidence. We may then say that the probability is 95 per cent that the geographic pole was situated within the locus during the period when the group of rocks we have used were formed. It need scarcely be said that for all groups in Table 2, except for the Oligocene rocks from France and the Eocene rocks from Ireland, the present geographic north pole is situated inside the locus.

Comparison of these loci with the alleged paths of the geographic north pole during geological time, as suggested, for example, by Kreichgauer, Köppen and Wegener, Milankovitch, and Köppen, shows that these paths cannot be reconciled with the new data. The amount of polar wandering in Tertiary and Quaternary times suggested by these theories is far too large. Even if one allows for (1) the alleged crustal shortening due to the Alpine orogeny, (2) possible uncertainties in the age determination of some of these groups of rocks, and (3) possible geological differences between the Continent of Europe and Iceland, this discrepancy remains.

However, the results from the Eocene flows of Ireland indicate that some change in the position of

geographic axis relative to Ireland may have taken place. Whether this is due to a movement of the entire crust relative to the earth's axis, or whether it is a movement of the entire Eurasian continent (or perhaps only of Ireland by itself) relative to the ocean floor and the earth's axis, we cannot say from these data. In any event, the movement, if real, is small and has not exceeded 5-10° since Eocene times.

A more detailed account of this work will be published elsewhere.

I wish to thank Mr. B. C. Browne and Dr. S. K. Runcorn, of the Department of Geodesy and Geophysics, University of Cambridge, for the interest they have taken in these investigations.

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Effect of Surface Diffusion on Rates of Adsorption

SOME striking results on the rates of adsorption of nitrogen on tungsten have recently been obtained by a flash filament technique¹. The rate of adsorption is expressed in terms of a 'sticking factor', s , the probability that a molecule striking the surface shall remain there. It is found that the sticking factor at 300° K. remains constant independent of surface coverage, θ , until there is about one nitrogen atom for every four tungsten atoms. As the temperature is increased by steps to 1,100° K., s both decreases for any given θ and also starts to fall off at lower surface coverages. It would seem that the decrease of s with rising temperature would not be expected from the usual picture of activated adsorption. Furthermore, although the decrease of rate with increasing θ may be influenced by repulsive forces between the adsorbed atoms, the decrease might be supposed to take place at a fixed θ , that is, at a certain distance between adsorbed atoms, and not to change with temperature as was found. Similar behaviour has been observed earlier for adsorption on catalysts, namely, a constant rapid rate of adsorption extending up to high surface coverages followed by a swift decrease as saturation is reached. A rate proportional to $\exp(-a\theta)$ has been proposed².

These results may be given a qualitative explanation by supposing that the adsorbate is able to migrate over the surface before being either desorbed or adsorbed in a particularly favourable position—a 'centre', formed possibly by some surface irregularity. If an atom is able to 'visit' such centres, a proportion θ of which are already filled, then the probability

that an atom is adsorbed on a centre is equal to the probability of its finding at least one centre unoccupied, that is, $1 - \theta^n$. Thus, if k is the number of atoms per second striking unit surface, the rate of adsorption will be given by $k(1 - \theta^n)$, as compared with the simple Langmuir expression $k(1 - \theta)$. With n large, the rate of adsorption remains approximately equal to k until θ is near 1, a behaviour similar to the $\exp(-a\theta)$ law.

The number n may be evaluated by supposing the atoms to move over the surface by activated diffusion, or as may be appropriate in some cases, by considering the atoms on the surface to form a two-dimensional gas. In both cases, n will be proportional to τ , the length of time spent by the atoms on the ordinary surface. τ is proportional to $\exp(E/kT)$, where E is the energy of adsorption on this surface. Thus, when T is small, n is large and the rate of adsorption does not fall off until $\theta \sim 1$. As T is increased, n decreases, and the rate of adsorption starts to fall off at lower θ .

Similar results may be expected for desorption. Two probabilities, k' and k'' , will exist for movement of an atom directly from a centre to the gas and for movement from a centre on to the ordinary surface. A subsequent desorption from the ordinary surface will take place provided the atom does not become attached to another centre. The probability of not finding another centre is θ^n , where n is the number of centres visited. The rate of desorption is therefore given by $k'\theta + k''\theta^n$. At low temperatures, and hence for a high value of n , the result is a rapid desorption falling roughly exponentially to a lower value given by $k'\theta$. As the temperature is raised and n lowered, the rapid desorption is maintained to lower values of surface coverage.

A result similar to this has been obtained by Langmuir for the desorption of thorium, oxygen and caesium from tungsten³. After a fast desorption, the rate drops to a lower value at a surface coverage which decreases with increasing temperature. Langmuir suggests that the desorption follows an exponential law proportional to $\exp(+b\theta)$.

I am indebted to Prof. G. Halsey for directing my attention to the results of Becker and Hartman and for helpful discussion.

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¹ Becker, J. A., and Hartman, C. D., *J. Phys. Chem.*, **57**, 153 (1953).

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Crystal Structure of the Intermetallic Compound $\text{Mg}_2\text{Cr}_3\text{Al}_{11}$

A TERNARY intermetallic phase with the approximate composition MgCrAl_2 , called the *H*-phase, was observed by Erdmann-Jeanitzer¹ in his examination of the magnesium-chromium-aluminium system. Little, Axon and Hume-Rothery² found that the magnesium content of the *H*-phase can vary considerably, and that, furthermore, zinc is soluble in the phase to some extent. Crystals extracted from two ternary alloys were found on analysis to have the compositions $\text{Mg}_2\text{Cr}_{2.1}\text{Al}_{11.1}$ and $\text{Mg}_2\text{Cr}_{2.01}\text{Al}_{11.1}$, and those of an *H*-phase sample containing zinc were

found to have the composition $\text{Mg}_2\text{Cr}_{1.3}\text{Zn}_{0.4}\text{Al}_{11.1}$. The results of micrographic investigation indicated that the range of composition extends at least from $\text{Mg}_2\text{Cr}_2\text{Al}_{11}$ to $\text{Mg}_2\text{Cr}_{1.2}\text{Al}_{11}$.

A report of a structure determination of the *H*-phase is given below. The determination is based on single-crystal X-ray diffraction data (copper $K\alpha$ radiation). The crystals used were isolated from an alloy containing a small amount of zinc (approximately 1.5 per cent by weight). A final refinement of the structure parameters is being made.

The space group is $O_h^1 - Fd\bar{3}m$, $a_0 = 14.55$ Å. The ideal composition of the crystals derived from X-ray data was found to be $\text{Mg}_2\text{Cr}_2\text{Al}_{11}$. The density of the crystals was found to be 2.80 gm./cm.³ by use of the flotation method. The calculated density is 2.86 gm./cm.³.

With the notation of the International Tables for X-ray Crystallography³ the structure may be described as in Table 1.

Table 1

No. of atoms	Position	Kind	Ligancy
96	f $8, 8, 8$, etc. $s = 0.067$; $s = 0.298$	Al	12
48	f $8, 0, 0$, etc. $s = 0.134$	Al	12
16	d $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$, etc.	Mg	14
8	b $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$, etc.	Mg	16
16	c $\frac{1}{2}, \frac{1}{2}, \frac{1}{2}$, etc.	Cr	12

The aluminium and chromium atoms have ligancy 12, and the magnesium atoms, which are larger, have ligancy 14 or 16. The bond distances are approximately $\text{Mg-Mg} = 3.15$ Å, $\text{Mg-Al} = 3.10-3.22$ Å, $\text{Al-Al} = 2.72-2.90$ Å, $\text{Al-Cr} = 2.58-2.78$ Å.

The *H*-phase represents a new structure type. At $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$ there is a group of six aluminium atoms (48 *f*) located at the vertices of a regular octahedron. Outside this group of atoms there are four chromium atoms at the vertices of a regular tetrahedron. Each of these atoms is shared between two such 10-atom complexes. At $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$ there is a magnesium atom (8 *b*) surrounded by a shell of twelve aluminium atoms (96 *g*). This shell may be described as a truncated tetrahedron, bounded by four nearly regular hexagons and four equilateral triangles. Out from the centres of the four hexagons of this shell there are four magnesium atoms located at the vertices of a regular tetrahedron. These magnesium atoms are shared by two such 17-atom complexes. The structure can thus be described as consisting of the two different kinds of groups, with each group surrounded by four groups of the same kind and four groups of the other kind. The packing of atoms is very good.

While the X-ray diffraction data suffice for determining which positions are occupied by chromium atoms, the distribution of magnesium and aluminium atoms over the occupied atomic positions has to be found by other means. Packing considerations indicate that the magnesium atoms are in the positions given above. This arrangement agrees fairly well with the composition found by chemical analysis² and is the most reasonable one if the structure is completely ordered with respect to the magnesium atoms.

The analyses of various *H*-phase samples² indicate some variation in the atom percentage of magnesium. In view of the considerable difference in size of the magnesium atoms and the chromium and aluminium atoms this variation is hard to explain. It seems

possible that the chemical analyses are inaccurate by amounts sufficiently large to resolve this difficulty.

At the present stage of the parameter refinement it is impossible to exclude the possibility of disorder of chromium and aluminium atoms. In view of the short nearest-neighbour distances around position 16c it is, however, likely that these positions are occupied exclusively by chromium atoms. In the position 96g disorder cannot be excluded, but the Fourier projection (xy) indicates that these positions are occupied nearly exclusively by aluminium atoms.

The work on the H -phase is being continued. Emphasis will be laid on the investigation of the range of composition of the H -phase in the ternary as well as in the quaternary system.

I wish to thank Prof. Linus Pauling for his interest in this work and for valuable discussions. I am also indebted to Dr. Gunnar Bergman for many valuable discussions and suggestions, and to Statens naturvetenskapliga forskningsråd in Stockholm for a travel grant to California.

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¹ Erdmann-Jennitzer, F., *Akademie-Archiv*, 29 (1940).

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Ionization and Excitation of Mercury Vapour by Positive Ion Impact

THE direct ionization of atoms by impact of positive ions, as postulated by Townsend in his theory of the electrical breakdown of gases, has been the subject of much controversy¹. Direct observation of ionization by ion impact is difficult, because the effect is small and is easily obscured by ionization due to secondary electrons or to photo-ionization by the short-wave radiations emitted by the source of ions. However, there is a growing body of evidence² that positive ions with energies of a few hundred electronvolts can ionize gases by impact. Recent work by Llewellyn-Jones and his co-workers in Swansea³ has revived belief in the validity of the Townsend hypothesis.

We have used a Geiger counter, with highly photo-sensitive cathode, to study the radiations emitted when potassium ions bombard mercury vapour. Effects due to electrons have been eliminated by use of appropriate electron traps, while the fact that the radiations come from the mercury has been verified by freezing out the vapour. The curves in Fig. 1 show how the counts due to the radiation vary with the energy and intensity of the beam of potassium ions. The Geiger counter was sheathed with glass, so that no short-wave ultra-violet radiation was detected.

It is seen that radiation was first detected at a bombarding energy of about 220 eV. and that the intensity, which is proportional to the beam current, increased monotonically with energy. Jones⁴ has shown that potassium ions of energy 300 eV. and above excite most strongly the ultra-violet 2537 Å.

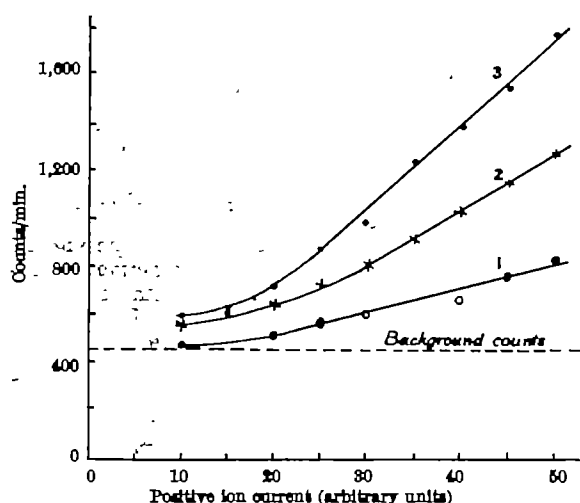


Fig. 1. Energy of positive ions: (1) 250 V.; (2) 550 V.; (3) 900 V

line of mercury and that the intensities do not change much in the energy-range 300–800 eV. We conclude that the radiations detected by us are largely recombination spectra following ionization of the mercury atoms by ion impact.

These observations are being extended and will be published in detail elsewhere.

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¹ Massey, H. S. W., and Burhop, E. H. S., "Electronic and Ionic Impact Phenomena", 583 (Clarendon Press, Oxford, 1952).

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Clinical and Metallurgical Observations on the Corrosion of Stainless Steel Screws used in Orthopaedic Surgery

WE wish to comment briefly on the recent article by Bowden, Williamson and Gowans Laing¹ in which they direct attention to the transfer of metal from the screw-driver to the head of an orthopaedic screw. While we are completely convinced by their experimental work on metallic transfer, we doubt the importance of this particular effect in promoting electrolytic corrosion of orthopaedic components. Particularly we would point out that the transfer of 65 μ m. of anodic material to the head of the screw would allow the corrosive dissolution of that 65 μ m. of material from the head of the screw, whereas clinical observation indicates that it is not the screw head which suffers the most serious corrosion. With stainless steel material the significant destructive corrosion, as distinct from superficial tarnishing, is concentrated at regions of contact between two metal components or between metal and bone. Moreover, in certain cases, as much as 1 gm. of metal may be dissolved away from one nut or screw. Corrosion at such regions obviously destroys the mechanical rigidity of the fixation. A more detailed account of

the theory of the distribution of destructive corrosion in orthopaedic screws is in course of preparation.

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¹ Bowden, F. P., Williamson, J. B. P., and Laing, P. G., *Nature*, 173, 520 (1954)

It may be useful to describe in a little more detail the nature of the welded particles of metal which are transferred from one surface to the other. Fig. 1 shows two taper sections, taken by Dr. A. J. W. Moore, illustrating typical fragments of copper which were welded on to a mild steel surface after the copper had slid over it once. There is evidence that, with most metals, the particles penetrate the oxide layer and adhere to the underlying metal. Since the resistance to corrosion of a stainless steel is due to the protection of its superficial oxide layer, the dissolution of these embedded foreign fragments, if they are anodic, may lead to a serious breakdown of the oxide layer and to the onset of continuing corrosion. If the adherent particles are cathodic (with these stainless steels the relative electrode potential is very dependent on the extent to which the oxide layer is disturbed and also on the surrounding medium; see, for example, Evans¹) continuing corrosion may again result. It would be unwise to assume that the transfer of 65 μ m. of material, anodic or cathodic, to the screw head would allow the corrosive dissolution of only 65 μ m. from the head.

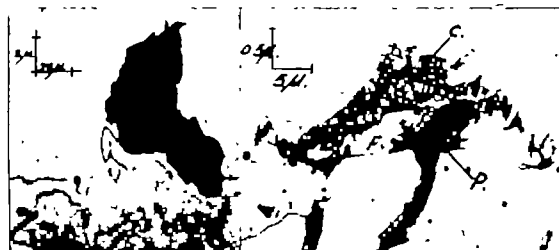


Fig. 1. Taper section photographs illustrating adherent metal fragments of copper (dark) on to steel. Note the rupture and penetration of the steel surface. C, copper; P, ferrite; P, pearlite

The particular screws and plates associated with the tissue reaction described in our article did not show any signs of gross destructive corrosion. It is well known that the corrosion can be influenced by a mechanical deformation of the surface, by differential aeration, by fretting corrosion and by changes in the pH value of the medium caused by sepsis. The relative importance of the different factors has been discussed by a number of workers.

Our experiments have indicated that there is another factor which should be considered—the transfer of metal from the tools. The presence of these adherent fragments of foreign metal is a possible cause of the observed tissue reaction adjacent to the regions handled, and the experiments suggest that attention should be given not only to the buried metals but also to the tools used to insert them.

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In our article we were not discussing heavy localized destructive corrosion and superficial tarnishing of orthopaedic components, since these are rarely found except when non-identical metals have been inserted or when sepsis has occurred. In all the cases we have examined there was no obvious sign of corrosion, but examination of the biopsy specimens showed that cellular reaction and iron infiltration had occurred in the tissue adjacent to the buried metals. This reaction is greatest near the screw and bolt heads, which have been handled by tools, and least near unhandled regions of the metal. It occurs in the absence of any concentrated destructive corrosion in the region of contact between the two components or between metal and bone.

The mechanical rigidity of the fixation will inevitably be destroyed within a month by the loosening of the screws in the bone. Evidence suggests that this is due, not to corrosion of the metal but to bone absorption caused by the pressure of the screw. Such absorption is known to be produced in other circumstances where no corrosion is possible, for example, where pressure is exerted by a locally enlarged artery.

The physical experiments have shown that localized transfer of a different metal can occur. Since this is a potential source of corrosion and of cellular reaction it is very important, from the surgical point of view, that it should receive due attention and, if possible, be avoided until our understanding of these physiological processes is more complete.

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Structure of Cobalt Complexes with Salicylideneanilines

THE structures of cobalt inner complexes with salicylideneanilines have not been determined, whereas the planar form of copper complexes of this type has been established beyond doubt by the isolation of *cis* and *trans* isomers¹ and by X-ray investigation². A difference in reactivity has now been observed between copper and cobalt ions with various salicylideneaniline bases which suggests a tetrahedral structure for the cobalt complexes. Attempts have been made to prepare complexes of the type *bis*-(salicylideneaniline)cobalt with bases containing aromatic amines bearing substituents in the *ortho*, *meta* and *para* positions. The compounds prepared are tabulated below together with the corresponding copper complexes previously prepared³.

The method of preparation has already been outlined⁴. It appears that cobalt shows a reluctance to form complexes with bases bearing bulky *ortho* substituents in the aniline ring, whereas copper forms complexes easily with *ortho*-, *meta*- or *para*-substituted amines. The one exception has been the *o*-anisidine cobalt complex. For those cases where cobalt failed to give the expected product, dark red

Amine component	Cu			Co		
	α -	β -	γ -	α -	β -	γ -
Toluidine	+	+	+	—	+	+
Chloroaniline	+	+	+	—	+	+
Aniline	+	+	+	—	+	+
Nitroaniline	+	+	+	—	+	+
Naphthylamine	+	+	+	—	+	+

¹ Prepared by the author.

+ Complex of expected type isolated.

— Complex of expected type not isolated.

¹ Evans, U. R., "Metallic Corrosion, Passivity and Protection" (Arnold, 1946).

solutions resulted on mixing the reactants just as in the cases where complexes were isolated. However, on cooling the former solutions, small amounts of red oils or tars were obtained in the cases of the *o*-toluidine and α -naphthylamine reactions and orange-red solids of indeterminate composition with *o*-chloroaniline and *o*-nitroaniline. The red oils, when dissolved in organic solvents and the solutions carefully evaporated, yielded only unchanged base and further tarry products. All other means of inducing crystallization of these products, for example, freezing and use of mixed solvents, were unsuccessful. The addition of sodium acetate or hydroxide to the reaction mixture was likewise unsuccessful.

It is therefore suggested that *ortho* substituents on the aniline ring can exert steric hindrance to stable complex formation in the case of cobalt, whereas this effect is either non-existent or much lessened in the case of copper.

Stackelberg⁴ has confirmed the planar configuration for *bis*(salicylideneaniline)copper by X-ray analysis, showing that the four donor atoms are co-planar with the copper. However, he observed that the aniline rings were tilted out of the plane of the donor atoms. Other evidence as to a general *trans* relationship of *R* and *R'* in salicylideneaniline bases ($R-CH=N-R'$) may be inferred from the studies of Hilbert, Liddell and Wulf⁵ on hydrogen bonding in such compounds and from the dipole moment measurements of Le Fevre and De Gaouac⁶. Thus, one may assume that the structure of the salicylideneaniline part of the complexes will be the same no matter what the arrangement of donor atoms about the central ion, that is, the substituted aniline ring will in each case be orientated at an angle to the plane of the salicylidene ring system. The construction of planar models of copper and cobalt complexes indicates that large *ortho* substituents such as $-OH$, or Cl — still permit considerable freedom of rotation of the aniline ring about the N—O linkage, although complete freedom of rotation could only be obtained through straining the model considerably. For a tetrahedral arrangement of ligands about the cobalt ion a greatly increased restriction is placed on the rotation of the aniline rings if co-ordination is to occur. *Meta* or *para* substituents appear to cause little or no restriction to rotation of the aniline ring for either planar or tetrahedral arrangements. Thus, with the knowledge that *bis*(salicylideneaniline)copper and presumably all other analogous copper complexes have planar structures, one may suggest this reported failure to isolate analogous cobalt complexes with *ortho* substituents provides indirect evidence of the tetrahedral formulation for the salicylideneaniline complexes of this element.

The isolation of the stable *o*-anisidine complex of cobalt seems to negate this hypothesis until one realizes that the methoxyl group may act as a co-ordinating centre and hence may enhance chelation rather than oppose it. The resulting complex may be pictured as possessing a distorted octahedral configuration.

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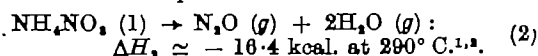
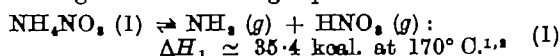
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⁶ *J. Chem. Soc.*, 741 (1933).

A Temperature-limiting Mechanism in the Thermal Decomposition of Ammonium Nitrate

WHEN ammonium nitrate is heated, two of its main reactions are dissociation and decomposition according to the following equations:



Ray and Jâná² have shown that reaction 1 is substantially complete in the vapour phase at low pressure. Reik³ has found the vapour pressure of the products to be 11 mm. at 210°C . From these values, the vapour-pressure curve for ammonium nitrate was estimated.

Despite the exothermic nature of reaction 2, the behaviour of unconfined ammonium nitrate on heating is not that of a typical exothermic reaction, in that it shows little tendency toward self-acceleration or even toward continued reaction after the source of heat is removed. This observation may be explained by postulating that, in decomposing ammonium nitrate, the gaseous products of reaction 2 issuing at the ambient pressure are saturated with the products of reaction 1 at their vapour pressure. When the temperature and, therefore, the dissociation pressure become sufficiently high, all the heat generated by the decomposition will be absorbed by the endothermic dissociation reaction. The reacting melt will then tend to seek a particular limiting temperature which is a function of the external pressure and of the heat supplied to, or removed from, the melt by its surroundings.

For the adiabatic case, a heat balance on the reacting mass leads to the equation:

$$P = \left[1 + \frac{3}{2} \left(\frac{\Delta H_1}{\Delta H_2} \right) \right] p, \quad (3)$$

where P is the external pressure, p is the dissociation pressure of ammonium nitrate at the temperature in question, and ΔH_1 and ΔH_2 are given above. Based on an estimate of the dissociation pressure versus temperature curve, the limiting temperature will be about 296°C . at an ambient pressure of one atmosphere.

Equation 3 was tested experimentally by electrically heating a sample of ammonium nitrate in an insulated vessel and measuring the reaction temperature under adiabatic conditions at various pressures. At one atmosphere, the steady-state temperature was 292°C . The equation gives reasonably good predictions of the limiting reaction temperature over a pressure range of 0.02–2.0 atmospheres.

The rate of reaction can be estimated from an experiment which illustrated the temperature-limiting effect. Liquid ammonium nitrate, preheated to above 250°C ., poured into a preheated Dewar flask shows an accelerating rate of heating up to the limiting temperature, where with the evolution of copious white fumes of sublimed ammonium nitrate the sample continues to decompose until it is exhausted. By weight loss, the reaction-rate is found to be first order; at 286°C . the half-life is about five minutes.

This work, which will be reported elsewhere in greater detail, was performed under the auspices of the United States Coast Guard and the Advisory Committee on Hazards of Ammonium Nitrate Transportation of the National Research Council. Per-

mission to publish this article has been granted by the United States Coast Guard; but neither of the sponsoring parties necessarily approves the technical opinions or conclusions.

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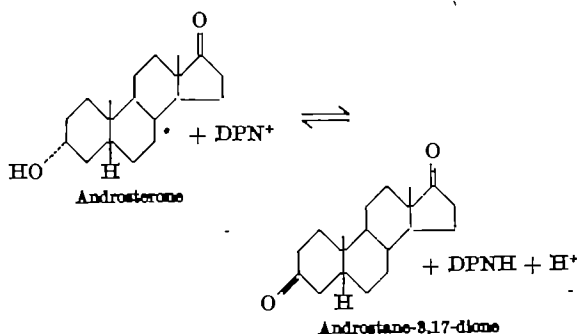
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Enzymatic Formation of 3 α -Hydroxysteroids

BUTENANDT¹ isolated the first crystalline androgen, androsterone, from human urine and determined its structure. The 3 α -hydroxysteroids, androsterone (androstan-3 α -ol-17-one) and etiocholan-3 α -ol-17-one, are the principal metabolites of endogenous androgens and of administered testosterone². The enzymatic mechanisms responsible for these interconversions have only been partly identified, and in particular the direct enzymatic interconversion of 19-carbon 3-ketosteroids and 3 α -hydroxysteroids has not been previously demonstrated. We wish to describe the isolation and purification of a steroid-induced (adaptive) 3 α -hydroxysteroid dehydrogenase of bacterial origin which catalyzes freely reversible interconversions of the type:



where DPN⁺ and DPNH refer to oxidized and reduced diphosphopyridine nucleotides respectively.

Cell-free extracts of a *Pseudomonas* sp. capable of growing on testosterone or related 19-carbon steroids³ contain a β -hydroxysteroid dehydrogenase⁴ which catalyzes reversible oxidations of 8 β and 17 β hydroxyl groups to the respective keto forms. The extracts containing the β -hydroxysteroid dehydrogenase also contain a DPN⁺-linked 3 α -hydroxysteroid dehydrogenase. Both enzymes are induced in response to the presence of testosterone or similar steroids in the growth medium. The 3 α -hydroxysteroid dehydrogenase has been purified some 30–50-fold over original extracts and virtually separated from β -hydroxysteroid dehydrogenase by the following steps: (1) ammonium sulphate precipitation at 45–55 per cent saturation; (2) precipitation of nucleic acids with protamine sulphate; (3) refractionation with ammonium sulphate (45–50 per cent saturation) in the presence of 0.005 *M* DPN⁺; (4) adsorption of impurities by calcium phosphate gel (pH 5.8).

The enzyme activity has been measured spectrophotometrically by observing the rate of appearance of the absorption band of DPNH at 340 m μ (Fig. 1, A)

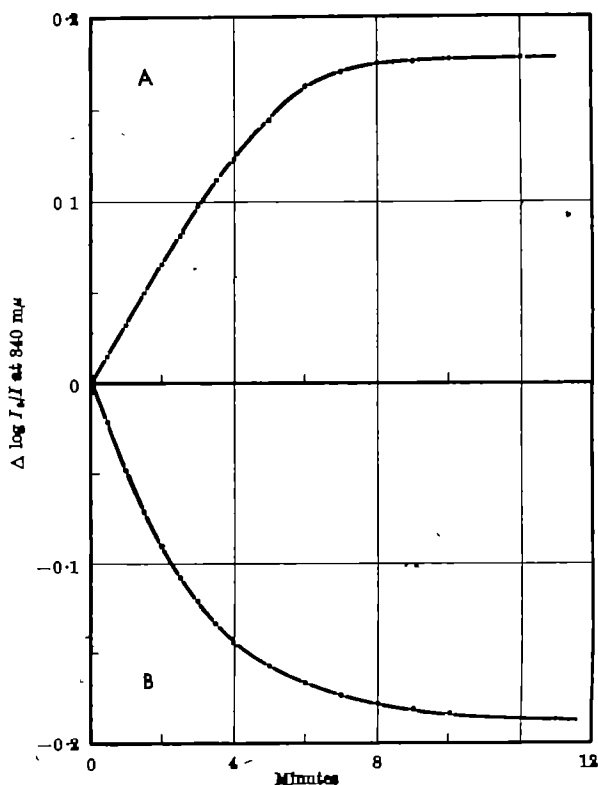


Fig. 1. (A) Conversion of androsterone to androstane-3,17-dione. Spectrophotometric measurement of reduction of DPN⁺ with time in a 3.0-ml. system containing: 100 μ M pyrophosphate buffer, 0.6 μ M DPN⁺, 25 μ gm. androsterone, and 7.2 μ gm. enzyme protein. Final pH 9.50; 25° C. 1.0 cm. light-path cells. (B) Conversion of androstane-3,17-dione to androsterone. Spectrophotometric measurement of oxidation of DPNH in a 3.0-ml. system containing: 100 μ M orthophosphate buffer, 0.25 μ M DPNH, 25 μ gm. androstane-3,17-dione, and 7.2 μ gm. enzyme protein. Final pH = 5.74; 25° C. 1.0 cm. light-path cells

or the rate of disappearance of the absorption of DPNH (Fig. 1, B) at 25° C. and appropriate pH. The enzyme is stable for at least several weeks at 0° in 0.005 *M* DPN⁺ solution; but is much less stable in the absence of its coenzyme. Free sulphhydryl groups appear to be necessary for activity inasmuch as the enzyme is strongly inhibited by 8×10^{-4} *M* mercuric ion, 3×10^{-3} *M* *p*-chloromercuribenzoate, 3×10^{-4} *M* ferrous ion and 3×10^{-4} *M* cupric ion.

The velocity of androsterone oxidation rises with increasing pH, whereas the reverse reaction is favoured by low pH. The equilibrium constant $K = [\text{androsterone}] [\text{DPNH}] / [\text{androstane-3,17-dione}] [\text{DPN}^+]$ is 0.13 at pH 7.4 and 25° C., and there is a linear relation of unit slope between $\log_2 K$ and the pH. The affinity between androsterone and the enzyme is extremely high. The accurate measurement of the Michaelis constant for this substrate presents technical difficulties, but is of the order of 1×10^{-4} *M* at pH 9.2 and 25° C. Under similar conditions the Michaelis constant for DPN⁺ is 1×10^{-4} *M*.

Specificity studies indicate that 3 α hydroxyl groups of both the androstane (A/B ring *trans*) or etiocholan (A/B ring *cis*) series are oxidized, but that other hydroxyl groups in positions such as 8 β , 6 β , 11 α , 11 β , 16 α , 17 α , 17 β and 21 are not oxidized. Conversely, only 3-ketosteroids are reduced by the enzyme to the corresponding 3 α -hydroxysteroids. If the 3-keto group is associated with either a $\Delta^{1,2}$ or a $\Delta^{4,5}$ double bond, the compound is not reduced under the conditions studied.

The products of the reaction in either direction have been identified by paper chromatography. Under suitable conditions (cf. Fig. 1) the equilibrium may be so shifted that the reaction is quantitative in either direction. This has made it possible to assay and identify specifically 3α -hydroxysteroids and saturated 3-ketosteroids in quantities of 1 microgram or less. The enzyme also provides a one-step stereo-specific synthesis of androsterone from androstane-3,17-dione.

The equilibrium constants of α and β hydroxysteroid dehydrogenase-catalysed reactions are such that at pH 7.4 the oxidation of 17 β -OH groups and the reduction of the 3-keto groups to 3α -OH groups are favoured. These enzymatic mechanisms may be responsible for two of the three postulated steps in the conversion of testosterone to androsterone and etiocholan- 3α -ol-17-one. Although the enzyme responsible for hydrogenation of the double bond remains unidentified, this reaction presumably precedes the reduction of the 3-keto group. Preliminary experiments have demonstrated the presence of 3α -hydroxysteroid dehydrogenase in mammalian tissues.

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Enzyme Inhibition

Katchalski, Berger and Neumann¹ have recently described the inhibition of pepsin by polylysine, polyornithine and poly-p-amino-phenylalanine. We would suggest that this is not an isolated effect but is an example of a widespread non-specific action of high molecular weight polyelectrolytes on many enzymes.

During recent years a number of references to such action have accumulated. For example, Hahn and his collaborators² have described the inhibition of hyaluronidase by polymers prepared from formaldehyde and various hydroxybenzoic acids; another team in Sweden³ has studied the inhibition of this enzyme, and of acid and alkaline phosphatases, hexokinase, urease and β -amylase, by phosphate polymers of various aromatic hydroxy and amino compounds. Heparin has been shown to inhibit hyaluronidase⁴, ribonuclease, deoxyribonuclease⁵ and α -amylase⁶; nitrated and acetylated hyaluronic acid⁷, cellulose and chitin sulphates⁸ inhibit hyaluronidase; phenolsulphonic acid-formaldehyde polymers inhibit hyaluronidase⁹, nucleases and α -amylase; polystyrene sulphonate, if of sufficient molecular size, also inhibits hyaluronidase (unpublished observa-

tions). The only characteristics which these inhibitors, with their varied chemical composition, appear to have in common are (a) high molecular weight, (b) polyanionic structure, and it seems probable that all substances with these two properties will exert some degree of inhibition against certain enzymes. It will be interesting in due course to discover the manner in which the potency varies with molecular size and with both proportion and type of anionic groups. We should mention, however, that a third feature has been suggested¹⁰ as necessary for inhibition of this kind, namely, that the molecules should be filamentous, since it is claimed that sulphonated glycogen and amylopectin, which are globular in form, do not inhibit hyaluronidase.

In view of the obvious importance of this general effect, it might be useful to introduce the term 'macroanion' for this class of substance and thus to refer to 'macroanionic inhibition'.

The work of Katchalski, Berger and Neumann¹ now suggests that a similar class of high molecular weight polycationic inhibitors ('macroocations') may also exist, these acting possibly upon a different group of enzymes.

Heparin (a macroanion) reverses this macrocationic inhibition of pepsin¹, in a manner similar to the reversal of the macroanionic inhibition of hyaluronidase by the macroocations protamine and methyl-gelatin⁴. Both effects must be due to some form of macroanion-macroocation interaction. A similar interaction may be involved also between enzymes and inhibitors of the type considered here and indeed in certain enzyme-substrate reactions themselves. Further study of the susceptibility of enzymes to macroanionic and macroocationic inhibition in concert with their chemical and physico-chemical properties may usefully further our understanding of enzyme action and inhibition both *in vivo* and in isolated systems.

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Fractional Precipitation of Nucleic Acid

MILVILLE *et al.*¹ have recently used turbidity measurements to follow the fractional precipitation of high polymers from solution. The turbid suspensions were found to be stable if very dilute polymer solutions were used. Nucleic acids are precipitated from aqueous solution by acids, cationic detergents, positively charged polyelectrolytes and alcohol. Stable suspensions are produced when hydrochloric

acid solution is used as the precipitant for very dilute nucleic acid solutions, but the use of alcohol rapidly coagulates the precipitate. Solutions of cetyltrimethylammonium chloride give results similar to hydrochloric acid but the suspensions tend to flocculate near the end-point of the precipitation.

Several samples of sodium deoxyribonucleate (DNA) prepared by different workers and from different sources were precipitated from aqueous solution by the gradual addition of 0.5 *N* hydrochloric acid and the turbidity of the solutions followed (Fig. 1). Within limits the DNA concentration did not affect the precipitation curves, and all the DNA solutions precipitated were 0.0037 per cent except those of wheat germ DNA. Reproducibility was good except for a commercial sample of calf thymus DNA supplied by Messrs. British Drug Houses, which probably consisted of degraded material extracted by acid and alkali treatment. Under the microscope ($\times 400$) the precipitates appeared as coacervate drops about 3μ in diameter which in some cases seemed to solidify on standing.

Degraded samples of DNA obtained by boiling aqueous solutions for different times were precipitated in the same way. Fig. 2 shows that DNA is more easily precipitated by hydrochloric acid the more it is degraded. It seems that in the precipitation of DNA by ionic precipitants the low molecular weight material is precipitated first, in contrast to the action of non-solvents on organic solutions of uncharged polymers. It will be interesting to see if this behaviour is typical of polyelectrolytes in general. The presence of sodium chloride also facilitates the precipitation (Fig. 2), probably due to the binding of Na^+ by the DNA. The hydrochloric acid precipitant does not significantly degrade the DNA (at least not sufficiently to affect the precipitation) since a sample which was made 0.2 *M* in hydrochloric acid and neutralized with sodium hydroxide gave precisely the same precipitation curve as a sample dissolved directly in 0.2 *M* sodium chloride (Fig. 2). In contrast, a sample treated with alkali and then neutralized by acid showed considerable degradation. Fig. 2 shows the effect of mixing a high molecular weight and a degraded sample; the same type of curve is still obtained with no extra inflexion.

The breaks in the curves in Fig. 1 at approximately 90 per cent turbidity for DNA from calf thymus suggest that there are two kinds of solute particles in these solutions. Two widely separated fractions of the same species will not produce a break in the

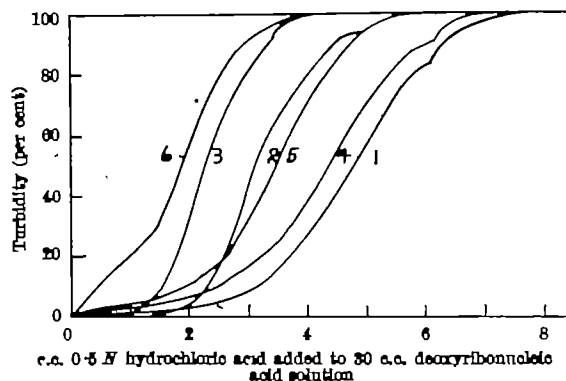


Fig. 2. Effects of salt, degradation and mixing high and low molecular weight samples. 1, Calf thymus DNA, *S*, in aqueous solution; 2, *S* in 0.06 *M* NaCl; 3, *S* in 0.2 *M* NaCl; *G*1(1) in 0.2 *M* NaCl; *G*1(1) made 0.2 *M* in HCl then neutralized by NaOH; 4, *A*1, untreated; 5, *A*1 boiled 8 min.; mixture of equal quantities untreated *A*1 and *A*1 boiled 5 min.; 6, *A*1 boiled 30 min.

curve as shown by the curve for the mixture in Fig. 2. This is in agreement with the suggestion of Sadron³ that some of the properties of DNA solutions are consistent with the presence of two kinds of particles, one type being significantly larger than the other. All the samples of DNA from calf thymus examined showed this effect but those from wheat germ and herring sperm did not. Cecil and Ogston⁴ found that thymus DNA which had been brought to pH 3.5 sedimented as two components. In other respects the general shape of the precipitation curves does not clearly indicate whether the DNA is polydisperse since the mixed sample (Fig. 2) gave the same shaped plot as all the others. Attempts to separate useful quantities of turbid precipitates from these very dilute solutions have not so far been successful.

Measurements of the extinction angles at low gradients in streaming birefringence were made and values of $(\tan \alpha)_0$ calculated. These results show that the amount of hydrochloric acid necessary to effect precipitation is a function of the molecular size of the DNA. The table shows that the value of $\log_{10}(\tan \alpha)_0$ is proportional to the quantity of hydrochloric acid necessary to precipitate 50 per cent of the DNA for the untreated samples. This may therefore be used as a rapid method of comparing the molecular sizes of different samples of DNA.

$\log_{10}(\tan \alpha)_0$	0.40	0.08	-0.06	-0.15	-1.35
Vol. HCl (c.c.) producing 50 per cent turbidity	4.73	4.40	4.04	3.80	2.20

This work is being extended and fuller reports should appear in due course. One of us (M. R. P.) is grateful to the Department of Scientific and Industrial Research for a research grant.

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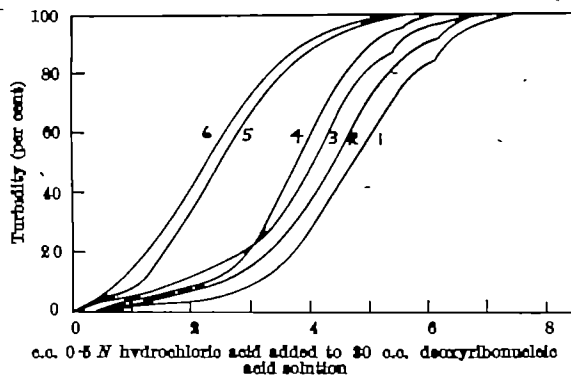


Fig. 1. Different samples of DNA. 1, calf thymus DNA, *S*; 2, calf thymus, *A*1; 3, calf thymus, T754; 4, calf thymus, *G*1(1); 5, herring sperm, from Messrs. Glaxo, Ltd.; 6, wheat germ, *A*1.

Action of Coumarin Anticoagulants on a Possible New Serum Clotting Factor

THERE have been several reports in recent years suggesting that a blood coagulation factor other than factor VII or prothrombin may be affected by the administration of coumarin anticoagulant drugs. Dam (personal communication, 1952) has detected such a factor in his experimental work in chickens, and more recently Koller¹ described a new factor, deficient in the blood of patients receiving coumarin anticoagulants, and unaffected by vitamin K.

Using serum from coumarin-treated patients as a source of factor VII and Christmas factor in the blood thromboplastin generation test², we have found that thromboplastin generation may be impaired when the corresponding one-stage test of Quick, which measures principally factor VII, is normal or very nearly so (Fig. 1). This has occurred both early in treatment before the one-stage test has lengthened, and on cessation of treatment soon after it has returned to normal. The same observation has been made after a single dose of a coumarin drug insufficient to make any change in the one-stage test. The sera from these patients gave normal blood thromboplastin generation in mixtures of platelets and plasma treated with aluminium hydroxide when they were not under the influence of the drug.

We have hesitated to ascribe these results to action on a new factor because the possibility existed that they might be due to an effect on Christmas factor, or that the thromboplastin generation test was a more sensitive index of factor VII deficiency than the one-stage Quick test. We now have carried out the thromboplastin generation test using more than two hundred samples of coumarinized serum in mixtures of normal platelets and plasma treated with aluminium hydroxide, and find that there is no apparent correlation between the results and moderate factor VII deficiency as indicated by the Quick test³. Moreover, we have found a similar phenomenon in patients with hepatocellular disease, but not so far

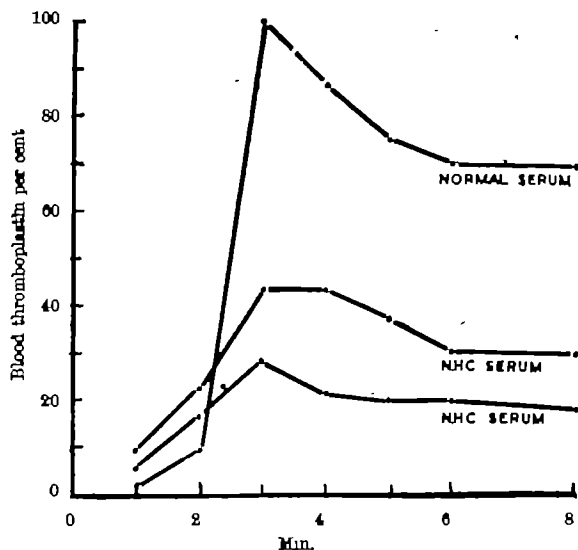


Fig. 1. Blood thromboplastin generated from the same mixture of platelets and plasma treated with aluminium hydroxide using normal serum (upper curve), and sera from two patients 48 hr. after a single dose of 200 mgm. naphthylhydroxycoumarin, when Quick test was normal.

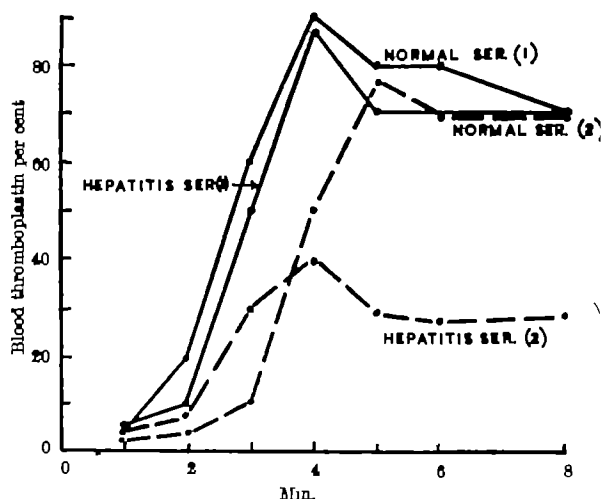


Fig. 2. (1) Normal thromboplastin generation using serum from patient with hepatitis: Quick test, 18 sec. (control 11 sec.). (2) Impaired thromboplastin generation three days later, using serum from same patient: Quick test, 16 sec. (control 12 sec.).

in obstructive jaundice. Fig. 2 shows normal thromboplastin generated in a mixture of platelets and plasma treated with aluminium hydroxide by the serum of a patient with infective hepatitis at a time when his Quick test was prolonged to 18 sec. (control 11 sec.) owing to deficiency of factor VII. Three days later his serum gave impaired thromboplastin generation, although his Quick test was now 15 sec. (control 12 sec.).

There is some evidence, therefore, in support of the suggestion by Koller that an additional factor is present in serum, though to our knowledge the behaviour of Christmas factor during coumarin administration or in liver disease has not yet been sufficiently studied to exclude deficiency in this factor as a cause of these findings.

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Unsuccessful Attempt to demonstrate a Paralytic Factor in Serum of Myasthenia Gravis Patients

So far there has not yet been any clear confirmation of the experiments of Wilson and Stoner¹, Adler² and others which were thought to have demonstrated the presence of a curare-like substance in the serum of myasthenic patients. As the presence of such a circulating paralytic factor cannot explain the abnormal reaction of myasthenic patients when injected with decamethonium³, we thought it desirable to attempt further confirmation of the results obtained by Wilson and Stoner.

We have had an opportunity of examining the serum of three patients who were suffering from serious myasthenia. Treatment was stopped 24 hr. before the experiments and the serum was examined within two hours after bleeding. The following experiments were carried out.

(1) Three dogs were injected intravenously with the serum (10, 40 and 60 ml.). They were then trotted for about half an hour. No abnormal fatigue could be ascertained.

(2) Fifteen cats were anaesthetized with luminal, whereupon the peripheral end of the severed sciatic nerve was stimulated with square-wave impulses. We applied tetanic stimulation with different frequencies up to 300 stimuli per second and single twitch stimuli (frequency: 54 impulses in 10 min.). The isotonic contractions of the tibialis muscle were recorded. The serum was injected intravenously (5-10 ml.), intramuscularly into the tibialis muscle (3-5 ml.) and intra-arterially into the art. femoralis (8 ml.). The serum could not be shown to cause a decrease of the contractions.

(3) Twenty rats were anaesthetized with urethane, and the peripheral end of the severed sciatic nerve was stimulated with square-wave impulses. Only single-twitch stimuli were applied, the frequency being 54 impulses in 10 min. The serum was injected intravenously (5 ml.). In this experiment, too, we failed to find any decrease of the isotonic contractions (that is, of the m. gastrocnemius).

(4) 5 ml. of serum was added to the Tyrode's solution of an isolated phrenic-diaphragm preparation of a rat as recommended by Bülbirg. The bath contained 100 ml. The serum had no effect on the contractions of the diaphragm.

(5) To the Ringer's solution of an isolated rectus abdominis preparation of a frog we added 2 ml. of serum, the bath containing 15 ml. Contractions of the muscle were evoked with 5 μ gm. acetylcholine. The serum of the patient caused a marked decrease of the muscular contractions, but it was no greater than that brought about by the control serum. So we may ascribe this decrease of the contraction to the cholinesterase of the serum.

(6) 3 ml. of serum was injected into a lymph space (sacculus thoracis) of a frog. During the following two hours, no abnormal flaccidity of the muscles could be observed.

(7) 7 ml. of serum of a myasthenic patient was injected into the m. flexor digit. subl. of a normal volunteer and of another patient. There was no objective decrease of muscular strength.

Although our experiments cannot be regarded as a definite proof against the theory that blood of myasthenic patients contains a substance which resembles curare, we believe that this conception appears less likely in the light of our results.

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A Remarkable Family with the Rare Human Isoantibody Anti- T_j^a In Four Siblings: Anti- T_j^a and Habitual Abortion

RECENTLY, Isaki and Masaki¹ reported what they believed to be a new isoagglutinin in the serum of a 27-year old patient who had six pregnancies all ending in abortions at two to five months. The serum of this group A, Rh-positive patient agglutinated the blood of each one of a hundred random bloods of groups O and A, independent of their Rh status. The serum, however, failed to react with its own red cells and the red cells of three out of four siblings. On the basis of absorption experiments, we believed that we were dealing with a single antibody which appeared to be different from anti-k (anti-Cellano) and anti-e, both of which give very high incidence of positive reactions.

Blood specimens (serum and clots) of the propositus and her three compatible siblings were sent by air-mail to the Ortho Research Foundation for identification of this unusual antibody. The sera and three of the clots were in excellent condition when received, but the blood of the propositus was completely hemolyzed.

On testing the four sera with fifty random group O bloods, positive reactions were obtained with all bloods. Each of the four sera, however, failed to react with the group O red blood cells of the Virginia patient in whose serum Levine *et al.*² described the first example of anti- T_j^a . Furthermore, the red cells of the three siblings failed to react with their own four sera and with three stock samples of anti- T_j^a . (In testing the two group A siblings, the activity of anti-A was neutralized by the addition of group A specific substance.) Thus, this unique Japanese family provides four additional examples of anti- T_j^a to the four already published and an additional five identified by one of us (P.L.). In all, there are now thirteen examples of anti- T_j^a in seven families scattered over five continents³.

The significant data in the Japanese family follow:

					Reaction with anti- <i>T₂</i> ^a	} parents not related to each other
Father Mother	O died	MN	R ₁ r		+	
Sib. 1	♂	O	MN	R ₁ R ₂	+	6 miscarriages unmarried
Sib. 2	♀	A	MN	R ₁ R ₂	0	
Sib. 3	♀	A	M	R ₁ R ₂	0	
Sib. 4	♂	O	MN	R ₁ R ₂	0	
Sib. 5	♂	O	M	R ₁ R ₂	0	
150 random bloods					+	
Red cells of Virginia patient					0	

The red cells of siblings 3, 4 and 5 were R_y^a positive and negative for $Kell$, Le^a and Jk^a . The antibody in each of the four siblings gave titres of 1/1 to 1/2 at 37° and 1/4 to 1/16 at 18° C. At 37° C. only traces of hemolysis were observed, but this may be due to deterioration of the complement in the interval of fourteen days between the shipment from Japan and the tests in Raritan, New Jersey.

In the absence of a history of antigenic stimulus by a transfusion, it may be assumed that anti- T_j^a is a naturally occurring antibody, which is regularly present if the red cells lack the very frequent blood factor T_j^a . In each case, the individual is of the very rare genotype $T_j^b T_j^b$ which determines the presence of anti- T_j^a —a state of affairs which is quite analogous to the distribution of anti-A and anti-B in the scheme of the four blood groups.

Levine and Koch⁴ have shown that the specificity of anti- T_j^a is distinct from that of the anti-H produced

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by the three group *O*, *Le(a +)*, *Tj(a +)* Indians described by Bhatia *et al.*⁴. This variety of anti-*H* resembles anti-*Tj*⁵ in its regular occurrence with a specific and very rare genotype and its reactions with all random bloods tested. Of the thirteen individuals producing or possessing anti-*Tj*⁵, nine are in group *O* and four in group *A*, and with one exception all those tested with anti-*Le*⁶ are negative.

The occurrence of six consecutive miscarriages of the propositus of the Japanese family is very remarkable, and their etiological relationship to the presence of anti-*Tj*⁵ is suggested by a history of miscarriages in each one of eleven pregnancies of three patients (4, 4 and 3 respectively) studied by Zoutendyk and Levine⁵, Hirszfeld and Grabowska⁶ and Levine *et al.*⁷. If one includes the Australian patient with one miscarriage (Walsh and Koopstzoff⁸), there is a total of eighteen miscarriages with no full-term pregnancies in five patients with anti-*Tj*⁵, all of whom are in the child-bearing age. The only exceptions are the first two Virginia siblings aged sixty-six and forty-three, in one of whose sera anti-*Tj*⁵ was first identified as a new antibody. Although not found in the younger sibling in 1951, anti-*Tj*⁵ was demonstrated in 1953. The two siblings had eleven (four and seven respectively) full-term, normal and successful pregnancies with no miscarriages. It now appears that the gastric adenocarcinoma in the older sibling bears no relationship to the presence of anti-*Tj*⁵ (Walsh and Koopstzoff⁸).

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⁵ Zoutendyk, A., and Levine, P., *Amer. J. Clin. Path.*, **22**, 630 (1952).

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Antitubercular Effect of an Extract of *Adhatoda vasica*

Adhatoda vasica is a small sub-herbaceous bush which grows all over the plains of India and is extensively used in indigenous medicine as a remedy for colds, cough, bronchitis and asthma. Hooper (1888) carried out its chemical analysis and found that it contained an odorous volatile principle and an alkaloid called vasicine. The alkaloid was found to have no action on tubercle bacilli (Chopra *et al.*, 1925).

The antitubercular activity of the volatile principle, which was obtained by steam distillation of the leaves, was determined by the serial dilution method, and the results are shown in the accompanying table.

ANTITUBERCULAR ACTIVITY

Drug	Strain No.	Inoculum	Inhibitory concentration (μgm./c.c.)
Volatile principle	B-10-4 (human)	0.01 mgm./c.c.	2
	B-10-3 (bovine)	"	5
	B-10-1 (avian)	"	5
	B-10-4	"	1
Streptomycin			

The activity of the drug is thus less than half that of streptomycin.

The drug does not produce any toxic symptoms in a dose of 2.3 gm./kgm. when administered to mice orally or subcutaneously.

Various concentrations of the drug were incorporated in the culture of bovine tubercle bacilli in liquid media, and the effect was studied under the electron microscope at various intervals. Under the influence of the drug there is inhibition of growth and the bacilli swell up (Figs. 1 and 2).



(1) Bovine strain of tubercle bacilli four days old. (2) Bacilli after 4 days treatment with active extract of *Adhatoda vasica*. × 10,500. Electron micrographs by Dr. A. Fande and K. Bahadur, National Physical Laboratory, New Delhi.

Details of this work will be published in the *Indian Journal of Medical Research*.

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Preparative Circular Paper Chromatography

FROM the preparative aspect, the conventional paper chromatographic technique is rather limited, in that only a few micrograms of material can be spotted on a single strip or sheet, and the labour involved in the separation of even milligram quantities in this way is enormous. From this point of view the circular paper chromatographic technique¹ offers great possibilities. By a suitable modification of this technique, it has been found possible to obtain from a single chromatogram material of individual components from a mixture of sugars sufficient for the determination of physical constants and preparation of characteristic derivatives.

The essential features of the technique consists in the use of thick and large-size circular filter paper (Whatman No. 3, 35 cm. diam.) and the application of the multiple development technique. The method consists in spotting 0.1–0.2 ml. at a time of the sample containing a mixture of sugars (about 20 per cent each of three to five sugars) at the centre of the paper and drying before another aliquot is superimposed on it until 0.5 ml. of the solution has been applied. The size of the spot can be as large as



Chromatogram showing the separation of large amounts of sugars from a mixture.

(1) Lactose (120 mgm.); (2) maltose (100 mgm.); (3) glucose (100 mgm.); (4) xylose (100 mgm.); (5) rhamnose (50 mgm.). Whatman No. 8 paper; 35 cm. diam. Solvent: *n*-butanol-pyridine-water (80:40:30). Four developments. Reagent: aniline-diphenylamine-phosphoric acid

1.5 in. in diameter. Using *n*-butanol-pyridine-water (80:40:30) as the developing solvent and applying the multiple development technique (four developments) previously described for the resolution of sugars by the circular technique³, clear separation of the sugars can be obtained. The bands relating to the individual sugars can be marked with pencil by cutting small sectors at different regions of the paper and using them as guide sectors after treatment with a chromogenic reagent. The marked-off zones are cut from the paper and the sugars are eluted with water, concentrated and crystallized in the usual manner. In this way 300–500 mgm. of sugars per sheet can be separated and isolated. More than one paper can be developed at a time by spotting the solution on each paper and placing them one above the other clamped between two thick glass plates having a hole at the centre. The development can be carried out by inserting a cylindrical paper wick through the holes, and reaching the solvent in a beaker. By this procedure it is possible to develop four or five chromatograms at a time. In this way large amounts of sugars can be separated. The accompanying photograph shows an example of the application of this technique, which should be of wide application as a preparative method of isolation of sugars and other substances which can be separated by paper chromatography.

A detailed account of this technique will be submitted for publication in the *Journal of the Indian Institute of Science*.

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Feb. 12.

Recovery of Lecithin from the Lecithin - Cadmium Chloride Complex

ALTHOUGH cadmium chloride has been in use at least since 1868 as a precipitant for lecithin, no completely satisfactory method for the removal of cadmium chloride from the complex formed in this manner has been devised. Strecker¹ used hydrogen sulphide to precipitate the cadmium. Bergell², in 1900, made use of ammonium carbonate, and Levene and Simms³, in 1921, introduced the procedure in recent common use, namely, treatment of a chloroform solution of lecithin-cadmium chloride with dry ammonia-methanol solution, both procedures resulting in the precipitation of a cadmium ammonium chloride complex. All these methods, in addition to resulting in poor yields, expose the easily oxidizable and labile lecithin to undesirably harsh treatment, with the result that, however pure the lecithin-cadmium chloride complex may have been, the lecithin finally isolated is once more somewhat impure.

It seemed probable that ion-exchange resins could be used to remove the cadmium chloride from the lecithin complex if a solvent could be found which fulfilled all the following conditions: (a) the complex would be soluble in the solvent, (b) the lecithin would be soluble, (c) the solvent would be sufficiently polar in character to enable the ion-exchange resin to function, and (d) it would not dissolve or in any other way alter the resin. A mixed solvent consisting of ethanol-water-chloroform (7:3:1 by volume) has been found to fulfil these conditions and to function as expected. (It is advantageous first to dissolve the lecithin-cadmium chloride in chloroform and afterwards to add the required amount of 70 per cent ethanol.)

The self-indicating, monobed resin 'Amberlite MB-3' (Resinous Products and Chemical Company) was used. Lecithin-cadmium chloride was prepared from soya bean phospholipids (kindly supplied by Victory Mills, Toronto) by the usual methods and once purified by the method of Pangborn⁴.

A description of two experiments will serve to illustrate the results which have been obtained. 'Amberlite MB-3' was equilibrated, in a flask, with several changes of the mixed solvent, after which a column of resin 10 cm. in height was prepared in an absorption tube 1 cm. in diameter and the solvent drawn off just to the top of the resin column. 500 mgm. of lecithin-cadmium chloride (containing 15.0 mgm. of phosphorus) in 10 ml. of the mixed solvent was introduced above the resin and allowed to flow down by gravity through the column at the rate of 1 ml. in 5 min. The solution was followed by more of the solvent at the same rate until six 5.0-ml. fractions of the effluent had been collected. On analysis these were found to contain 0, 0.65, 6.7, 7.0, 0.65 and 0 mgm. of phosphorus respectively, thus accounting for all the phosphorus. The third effluent fraction contained 3.04 mgm. of nitrogen representing a nitrogen-phosphorus ratio of 1:1.00. Neither cadmium nor chloride was to be found in any of the effluent fractions.

On a slightly larger scale, 2,808 mgm. of lecithin-cadmium chloride in 45 ml. of the mixed solvent was passed at the same rate through a resin column 0.9 cm. x 25 cm. (a 25-ml. burette was used) and followed by 50 ml. of the same solvent at a somewhat faster rate. The effluent was collected in a weighed 300-ml. standard-joint flask and the solvent distilled

¹ Grl, K. V., and Rao, N. A. N., *Nature*, 160, 923 (1953); *J. Ind. Inst. Sci.*, 34, 95 (1953); *Nature*, 171, 1159 (1953).

² Grl, K. V., and Nigam, V. N., *Naturwissenschaften*, 40, 343 (1953); *J. Ind. Inst. Sci.*, 35, 49 (1954).

off *in vacuo* under nitrogen with an all-glass apparatus. (The water-bath temperature was not above 30° C.) Three 10-ml. portions of absolute ethanol were added and each successively distilled off under the same conditions to effect removal of the water. Finally, the contents in the flask were dried to a constant weight in a vacuum desiccator over phosphorus pentoxide and in the presence of nitrogen. The lecithin, a transparent, colourless and amorphous solid, was dissolved in absolute ethanol, quantitatively transferred to a 50-ml. volumetric flask and made to volume. The weight of the lecithin thus prepared was 1,777 mgm. According to Baer and Kates¹, the complex has the structure (lecithin), (cadmium chloride). Assuming a molecular weight of 802 for this lecithin, the yield should have been 1,720 mgm. A lecithin containing one molecule each of stearic and linolenic acids would have a molecular weight of 802 and the following calculated analytical figures: P, 3.86; N, 1.75 per cent; iodine number, 95; analysis gave P, 3.83; N, 1.73; choline-N, 1.73 per cent²; N:P ratio, 1:1.00; iodine number, 86. (It is not to be construed that this is evidence for the presence of stearic or linolenic acids.) The lecithin is optically active, $[\alpha]_D^{25} = 7.0$ (in ethanol). A 10 per cent solution of the lecithin in ethanol has been kept at room temperature for two months without discoloration.

The method described here, when used in conjunction with the excellent procedure of Pangborn for the purification of lecithin—cadmium chloride, makes possible the easy preparation of naturally occurring, unsaturated lecithins with a high degree of purity.

This work was assisted by a grant from the Division of Medical Research, National Research Council of Canada.

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Halifax, N.S. Feb. 10.

¹ Strecker, A., *Liebigs Ann.*, 148, 77 (1868).

² Bergell, P., *Ber. deutsch. chem. Ges.*, 33, 2584 (1900).

³ Levine, P. A., and Stimms, H. S., *J. Biol. Chem.*, 48, 185 (1921).

⁴ Pangborn, M. O., *J. Biol. Chem.*, 137, 545 (1941); 161, 71 (1945).

⁵ Baer, B., and Kates, M., *J. Amer. Chem. Soc.*, 72, 943 (1950).

⁶ Handler, P., *Biol. Symposia*, 12, 361 (1947).

Soil Recolonization Tube for studying Recolonization of Sterilized Soil by Micro-organisms

STUDIES of recolonization by fungi and bacteria of soil sterilized, or partially sterilized, by steam or by various fumigants such as formalin, carbon disulphide and chloropicrin have been made by many investigators. A difficulty common to all such investigations has been that of taking samples of the soil in the process of recolonization for plating out and determination of the recolonizing micro-organisms. If the soil has been treated *in situ* in the field, it is necessary to dig profile pits, from the sides of which samples can be taken¹. If the soil has been treated in laboratory containers, it may be necessary to sacrifice one container of soil for each series of samples taken, and this makes it impossible to make consecutive observations on the soil in a

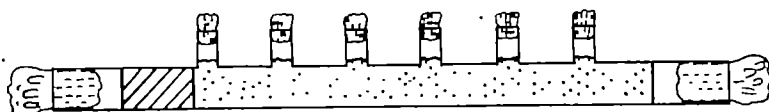


Fig. 1. Soil recolonization tube: hatched, non-sterile inoculum; stippled, sterile soil

single container. Furthermore, the disturbance consequent upon removal of soil before taking a sample much increases the likelihood of contamination of the soil samples by adventitious micro-organisms. To overcome these difficulties, the 'soil recolonization tube', illustrated in Fig. 1, has been designed and found useful in the study of fungal recolonization of sterilized soil. It is proving equally useful for the investigation of soil recolonization by bacteria. By the use of this apparatus, soil samples can be taken with the minimum of labour and of disturbance to the surrounding soil; moreover, successive samples of soil can be taken from a single recolonization tube for an indefinite period, and the succession of recolonizing organisms in space and time can be properly studied.

The recolonization tube consists of an 18-in. length of 'Pyrex' glass tubing, of 1-in. internal diameter, to which six side-arms, 1 in. long and $\frac{1}{4}$ in. internal diameter, are fused at 2-in. intervals. The tube is packed with moist soil, which has previously been passed through a 2-mm. sieve and adjusted to a moisture content of 40 per cent saturation. Trim and even packing is secured by tamping after each addition of 25 gm. of soil. After the tube has been filled, the open ends of the main tube and of the six side-arms are plugged with cotton wool and the whole tube is weighed; soil moisture content can then be maintained at the original level by periodical weighing and restoring to original weight by addition of sterile water through the side-arms (starting at the end farthest from the inoculum of unsterilized soil). If recolonization of steamed or autoclaved soils is to be studied, the tubes can be steamed or autoclaved in the usual way; for treatment of soil with a fumigant such as carbon disulphide or chloropicrin, the cotton-wool plugs are replaced, for the duration of the treatment, by rubber bungs. After the sterilization treatment has been completed and the necessary additional period allowed for evaporation of a volatile fumigant, an inoculum of unsterilized soil is added at one end of the recolonization tube. At suitable intervals of time, small samples of soil are removed through the side-arms of each tube, and from them 'Warcup soil plates' are made for determination of the fungus flora².

Consistent results have been obtained with this technique in successive trials of sterilized and re-inoculated Kettering loam soil. After steam treatment at 1 atm. pressure for 30 min. on two successive days, the first fungal colonists following reinoculation with unsterilized soil were phycomycetous species, such as *Pythium acaeticum* and *Zygomorphus oultonii*. These were regularly followed by *Trichoderma viride*, *Mucor ramannianus* and *Fusarium caeruleum*. If the soil was not packed sufficiently firmly, however, *Trichoderma viride* tended to be the first fungal colonizer.

E. EVANS

Botany School,
Cambridge.

Feb. 24.

¹ Warcup, J. H., *Trans. Brit. Myc. Soc.*, 34, 519 (1961).

² Warcup J. H., *Nature*, 195, 117 (1960).

FORTHCOMING EVENTS

Monday, June 21

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8 p.m.—Annual General Meeting.

LECTURES OF METAL FIRMING (at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6.15 p.m.—Mr. R. L. Samuel and Mr. N. A. Lockington: "Chromium Diffusion as a Commercial Process".

Friday, June 25—Saturday, June 26

BRITISH MYCOLOGICAL SOCIETY (at Cambridge)—Scientific Meeting.

Friday, June 25

At 10.30 a.m. (at the National Institute of Agricultural Botany, Cambridge)—Twenty-eighth Annual Plant Pathology Field Day.

Saturday, June 26

At 9.30 a.m. (in the Large Lecture Room, Botany School, Cambridge)—Scientific Papers on "Infection Phenomena".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

BIOCHEMIST to take part in work on the formation of protein complexes in the dyeing of wool and related problems, with particular reference to soil forming processes—The Secretary, Department of Forestry, Imperial Forestry Institute, University of Oxford (June 23).

DEPUTY CONTROLLER (graduate in physics, chemistry or fuel technology, and experienced in domestic fuel utilization, and the assessment of coke qualities) at the PHYSICAL TESTING LABORATORIES, Bloom Street, Salford, to supervise the examination and testing of all types of gas and coke appliances for domestic use—The Secretary, North Western Gas Board, 60 Whitworth Street, Manchester 1 (June 24).

ASSISTANT, Grade B (with good academic qualifications) in CHEMISTRY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (June 25).

RESEARCH ASSISTANT in the DEPARTMENT OF APPLIED MATHEMATICS for theoretical work on upper atmosphere physics—The Professor of Applied Mathematics, Queen's University, Belfast (June 25).

ASSISTANT, Grade B (with a degree or equivalent qualification, and preferably with industrial and/or teaching experience) in the DEPARTMENT OF METALLURGY, County Technical College, Wednesbury—The Director of Education, Department F.B., County Education Office, Stafford (June 26).

ASSISTANT LECTURER (with special qualifications in applied mathematics) in MATHEMATICS—The Registrar, The University, Manchester (June 26).

ASSISTANT LECTURER (with special qualifications in petrology) in GEOLOGY—The Registrar, Trinity College, Dublin (June 26).

EXPERIMENTAL OFFICERS (3) (with a pass degree, H.N.C. or equivalent, in physics), or ASSISTANT EXPERIMENTAL OFFICERS (2) (with G.C.H. in three subjects at advanced level, two of which must be in a science subject), at the NATIONAL PHYSICAL LABORATORY, Teddington, Middlesex, for work on (a) precision temperature and pressure measurements and (b) radiology—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.149/54A (June 26).

LECTURER (honours graduate, with a knowledge of advanced physical metallurgy and an interest in X-ray metallography) in the DEPARTMENT OF METALLURGY—The Registrar, The University, Liverpool (June 26).

LECTURER (preferably with special qualifications in palaeontology and stratigraphy) in GEOLOGY—The Registrar, King's College (University of Durham), Newcastle-upon-Tyne (June 26).

SCIENTIST, Grade II or III (with a first- or good second-class honours degree in physics, engineering, biology, mathematics or statistics, and experience in field, laboratory or operational research, and preferably with experience in the writing of research reports) in the FIELD INVESTIGATION GROUP, to carry out field work as collector, and some will take charge of small teams—The National Coal Board Establishments (Personnel), Hobart House, London, S.W.1, quoting TT/781 (June 26).

ASSISTANT AGRICULTURAL ECONOMIST (with a degree in economics or agriculture with economics) in the DEPARTMENT OF AGRICULTURAL ECONOMICS—The Registrar, The University, Manchester (June 26).

LECTURER in PHYSIOLOGY—The Secretary of University Court, The University, Glasgow (June 26).

PRINCIPAL SCIENTIFIC OFFICER (preferably with some previous experience in the physiology of the nervous system and of the special senses, and a first- or second-class honours degree in an appropriate subject) at the R.A.F. Institute of Aviation Medicine, Centrifuge Unit, South Farnborough, Hants, to take charge of small scientific unit concerned with the effects of acceleration on man and animals, and to be responsible for detailed planning, from a fundamental aspect, of a long-term programme of a physiological nature dealing largely with changes in the circulation—The Civil Service Commission, Scientific Branch, 90 Old Burlington Street, London, W.1, quoting S.4339/54 (June 26).

RESEARCH SCIENTISTS (with a good university degree or equivalent in physics, physical chemistry or electrical engineering) for work on coal preparation, also laboratory and pilot scale investigation into novel methods of separating coal from associated minerals—The National Coal Board Central Research Establishment, Stoke Orchard, near Cheltenham, Glos. quoting TT/783 (June 26).

UNIVERSITY DEMONSTRATOR (preferably with qualifications in stratigraphy) in the DEPARTMENT OF GEOLOGY, University of Cambridge—Mr. W. B. Harland, Secretary of the Appointments Committee of the Faculty of Geography and Geology, Sedgwick Museum of Geology, Downing Street, Cambridge (June 25).

ANALYTICAL CHEMIST in the DEPARTMENT OF AGRICULTURAL CHEMISTRY—The Registrar, Wye College, near Ashford, Kent (June 30).

LECTURER in BIOCHEMISTRY at University College, Dundee—The Secretary, University of St. Andrews, College Gate, St. Andrews (June 30).

LECTURER in ECONOMIC STATISTICS at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, June 30).

LECTURER in HISTOLOGY within the Department of Anatomy—The Medical Secretary, Middlesex Hospital Medical School, London, W.1 (June 30).

LECTURER (with special interests in fluid mechanics) in ENGINEERING—The Registrar, King's College, Strand, London, W.C.2 (June 30).

LECTURERS, Grade I, in AGRICULTURE, and an ASSISTANT LECTURER in ANIMAL HUSBANDRY, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (June 30).

PHYSICIST, basic grade (with a first- or second-class honours degree in physics, whose main interests lie either in classical physics or in atomic physics), in the REGIONAL PHYSICS DEPARTMENT—The Administrative Officer, Board of Management for Glasgow Western Hospitals, Regional Physics Department (Western Regional Hospital Board), 9-11 West Graham Street, Glasgow, G.4 (June 30).

PROFESSOR OF AGRICULTURE—The Registrar, The University, Reading (June 30).

LECTURER in CHEMICAL PATHOLOGY at the University College of the West Indies—The Secretary, Senate Committee on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (July 1).

LECTURER in PSYCHOLOGY—The Secretary, London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2 (July 1).

RESEARCH ASSISTANT (with a degree in chemistry) in the DEPARTMENT OF CHEMISTRY AND BIOLOGY—The Secretary, Norwood Technical College, Knight's Hill, West Norwood, London, S.W.17 (July 1).

LECTURER in BIOPHYSICS in the DEPARTMENT OF PHYSIOLOGY—The Secretary, The University, Edinburgh (July 3).

SENIOR LECTURER, and a LECTURER, Grade I, in CHEMISTRY, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 3).

ASSISTANT LECTURER in PHYSICS—The Registrar, University College of North Staffordshire, Keele, Staffs (July 10).

CHAIR OF CHEMISTRY in Makerere College, University College of East Africa—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 10).

LECTURER and an ASSISTANT LECTURER in the DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Manchester 13 (July 10).

LECTURER in INORGANIC AND PHYSICAL CHEMISTRY—The Secretary, The University, Edinburgh (July 15).

ASSISTANTS (2) in the DEPARTMENT OF ZOOLOGY—The Secretary, The University, Edinburgh (July 17).

CHAIR OF ANATOMY at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Hong Kong, July 31).

PROFESSOR OF MICROBIOLOGY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

SENIOR LECTURER in CIVIL ENGINEERING at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Hong Kong, July 31).

ASSISTANT, Grade B (with graduate or A.B.I.C. qualifications) in CHEMISTRY—The Principal, Technical College, Queen Street South, Huddersfield.

BACTERIOLOGICAL TECHNICIAN to assist in an investigation of bacterial viruses, and to be fully responsible for the preparation of media—The Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3.

BIOLOGIST (Assistant Experimental Officer or Experimental Officer grade), to work on plankton in the Edinburgh Laboratory of the Scottish Marine Biological Association—The Officer in Charge, Oceanographic Laboratory, 78 Orleigh Road, Edinburgh 5.

ELECTRONIC ENGINEERS and PHYSICIANS (Scientific Officer, Assistant Experimental Officer and Experimental Officer grades), at Ministry of Supply Experimental Establishments at Farnborough, Hants, Malvern, Wotton, and Sevenoaks, Kent, and elsewhere, mainly in Southern England, for duties which include research, development or design of telecommunications and radar equipment; guidance and control systems; and instrumentation for a variety of research problems—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting D.206/54A.

INDEXER (female) (preferably with a degree or equivalent), to assist in preparing indexes, answering inquiries and proof reading—The Director, Commonwealth Bureau of Dairy Science, Shinfield, Reading, Berks.

MATHEMATICIANS (Scientific Officer, Assistant Experimental Officer and Experimental Officer grades), at Ministry of Supply Research and Development Establishments mainly in Southern England, for work on a wide range of problems chiefly concerned with aircraft, radio and radar equipment and armaments—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.141/54A.

MINERALOGIST CHEMIST (with first- or good second-class honours degree in geology or chemistry, and experience in the analysis, identification, study, etc., of mineral species), with H.M. Colonial Service in Tanganyika—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD 106/8/04.

PHYSICIST or MECHANICAL ENGINEER to undertake fundamental and applied research on certain mechanical processes employed in textile finishing; a **PHYSICIST or TEXTILE TECHNOLOGIST** for fundamental and technical researches in the process of doubling, which consists essentially of the twisting together of yarns; and a **PHYSICIST or RESEARCH ENGINEER** (preferably with a knowledge of experimental stress analysis) for research on weaving machinery.—The Director, British Cotton Industry Research Association, Solihull Institute, Didsbury, Manchester 20.

PHYSICIST (with a degree in physics and capable of applying experimental techniques to the solution of fluid problems in the iron and steel industry) in the **FLUID DYNAMICS SECTION** of the Physics Department, British Iron and Steel Research Association, London—The Personnel Officer, B.I.S.R.A., 11 Park Lane, London, W.1.

RESEARCH ASSISTANT in the field of PHYSICAL CHEMISTRY—The Secretary, University College, Exeter.

RESEARCH ASSISTANT (science graduate (physiology or biochemistry)), in the **BLOOD PRODUCTS LABORATORY**—The Secretary, Lister Institute, Herts, Herts.

SCIENTIFIC OFFICER, Grade 8 (with a university degree of high standard in aeronautical engineering or equivalent qualifications, and several years experience in wind tunnel investigations related to the aerodynamic development of aircraft and missiles), in the **AERONAUTICAL RESEARCH LABORATORIES**, Fishermen's Bend, Victoria, Australia, to work on the aerodynamic development and research relating to new types of aircraft and missiles, and to general problems in low speed aerodynamics—The Senior Representative (A.P.17), Department of Supply, Australia House, London, W.O.2, quoting "Position No. 239".

SENIOR LABORATORY TECHNICIAN (with experience in a physics laboratory of an educational institution) in the **PHYSICS LABORATORY**—The Secretary, Borough Polytechnic, Borough Road, London, S.E.1.

SENIOR LABORATORY (with at least three years teaching experience at a British university) in (a) **CIVIL ENGINEERING** (including surveying), (b) **ELECTRICAL ENGINEERING** (electro power), and (c) **Mechanical Engineering** (heat engines and refrigeration), at the Engineering College, Rangoon University—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.12/B.M. (a), (b), (c)/54.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

- Journal of the Royal Institute of Chemistry. Vol. 78, 1954: Supplement 1-86: Annual Report of the Council for 1953. Pp. 86. (London: Royal Institute of Chemistry, 1954.) [234]
 Rheumatism and Mental Depression, etc. By Peter F. Somerville. Pp. 46. (Bournemouth: Peter F. Somerville, 1954.) [234]
 Reports of the Council and Auditors of the Zoological Society of London, for the year 1953. Pp. 40+4 plates. (London: Zoological Society of London, 1954.) [234]
 Sudan Government. Ministry of Agriculture. Bulletin No. 18: Weeds of the Gezira Scheme. Compiled by Dr. F. W. Andrews. Pp. 66. (Aberdeen: T. Bunde and Co. Ltd., 1954. Published for the Sudan Government.) 5s.; 25 pasteres. [234]
 Department of Scientific and Industrial Research. National Building Studies. Research Paper No. 19: Dynamic Stresses in Cast Iron Girder Bridges. By G. R. Mitchell. Pp. vi+48+12 plates. (London: H.M. Stationery Office, 1954.) 3s. net. [234]
 Royal Institute of Chemistry. Lectures, Monographs and Reports, 1954. No. 2: Hydrogen Peroxide. By W. S. Wood. Pp. ii+25+2 plates. (London: Royal Institute of Chemistry, 1954.) [234]
 Textile Institute. Education for Careers in Textiles: a guide to educational opportunities in textile technology in the United Kingdom. Pp. 52. (Manchester: Textile Institute, 1954.) [234]
 Sir John Cass College. Report—Session 1953-54. Pp. 20. (London: Sir John Cass College, 1954.) [234]
 Flora of Tropical East Africa. Edited by W. B. Turrill and H. Milne-Redhead. Chomopodaceae. Pp. 26. (London: Crown Agents for Overseas Governments and Administrations, 1954.) 2s. [234]
 Petroleum Information Bureau. U.K. Petroleum Industry Statistics relating to Consumption and to Refinery Production, 1953 and 1954. Pp. 8. (London: Petroleum Information Bureau, 1954.) [234]
 The Baker Interference Microscope. Pp. 22+3 plates. (London: G. Baker of Holborn, Ltd., 1954.) [304]

Other Countries

- Phenology and Thermal Environment as a means for a physiological classification of Wheat Varieties and for Predicting Maturity Dates of Wheat. By M. Y. Nuttonson. (Based on Data of Ozeochovalva and of some Thermally Analogous Areas of Ozeochovalva, in the United States Pacific Northwest.) Pp. 108. (Washington, D.C.: American Institute of Crop Biology, 1953.) [214]
 Stanford Research Institute. Annual Report for 1953. Pp. 48. (Stanford, Calif.: Stanford Research Institute, 1954.) [214]
 Bibliography of Fishes in Japan (1612-1950). Pp. iv+238. (Osaka: Prefectural University of Education (Faculty of Fisheries), 1953.) [214]
 U.S. Department of Agriculture. Leaflet No. 121: The Sweet-potato Weevil and How to Control It. Pp. 7. (Washington, D.C.: Government Printing Office, 1954.) 5 cents. [214]
 United States Naval Observatory. Circular No. 47 (January 25, 1954): Positions, Areas and Counts of Sunspots, November-December, 1953. By Winifred Sawtell Cameron. Pp. 4. Circular No. 48 (March 1, 1954): Solar Summary for 1953. Pp. 11. (Washington, D.C.: U.S. Naval Observatory, 1954.) [214]
 Geological Survey of the Anglo-Egyptian Sudan. Report for 1950-1953. By Gerald Andrew. Pp. ii+51. (Khartoum: Sudan Government Geological Survey, 1953.) 40 pasteres; 8s. [214]

Proceedings of the Eastern Joint Computer Conference. (Papers and Discussions presented at the Joint IRE-AIEE-AOM Computer Conference, Washington, D.C., December 8-10, 1953.) Pp. 125. (New York: Institute of Radio Engineers, Inc., 1954.) 3 dollars. [214]

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East African Meteorological Department. Summary of Meteorological Observations for 1953. Part 1: Kenya. Pp. 80. Part 2: Tanganyika. Pp. 32. Part 3: Uganda. Pp. 17. Part 4: Zanzibar. Pp. 3. (Nairobi: East African Meteorological Department.) [214]

Food and Agricultural Organization of the United Nations. Indo-Pacific Fisheries Council. List of Scientific and other Periodicals published in the Indo-Pacific Area. Second edition, revised. Pp. 50. (Bangkok: Indo-Pacific Fisheries Council, FAO Regional Office for Asia and the Far East, 1953.) [214]

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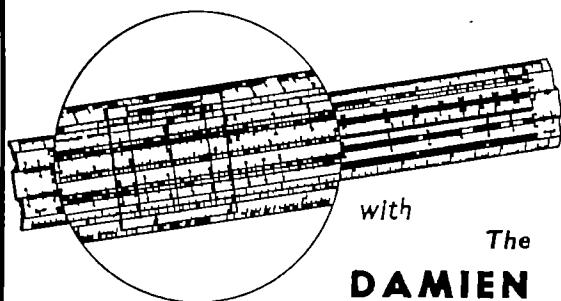
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Applications are invited for the following post Tobacco Research Officer, Department of Agriculture, Nyasaland, to carry out experimental work on tobacco growing and curing under the general direction of a tobacco expert. Candidates must be male, and should possess a good honours degree in botany, agricultural botany or agriculture, and have had at least two years' postgraduate training and experience in field experimentation and crop husbandry generally. Appointment on probation in the Colonial Research Service in either the Scientific Officer scale (£400 to £650 per annum, plus an overseas research allowance of £100 to £140 per annum) or the Senior Scientific Officer scale (£750 to £950 per annum, plus an overseas research allowance of £135 to £220 per annum), according to age and experience. Local cost-of-living allowance, at present at the rate of 20 per cent of first £500 of salary and 10 per cent of remainder (maximum £200 per annum) also payable. Outfit allowance £60 on first appointment. Contributory superannuation scheme. Income tax at local rates. Free passages on appointment and leave for officer, wife and children under 13 years of age. Government quarters, when available, at a rental of up to 10 per cent of basic salary (maximum £150 per annum).

Apply in writing to the Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, giving briefly age, qualifications and experience. Mention the reference number CDE 63/4/04.

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SOUTH PACIFIC COMMISSION
PHYSICIAN-NUTRITIONIST

Applications are invited for the post of Physician-Nutritionist with the South Pacific Commission. The Physician-Nutritionist will be stationed in Noumea, New Caledonia, and will be required to assist and stimulate the assessment and improvement of the dietary patterns and nutritional status of the South Pacific peoples. To this end he will have to direct, co-ordinate and supervise the work of a dietitian-nutritionist, a biochemist and a food technologist, and to co-operate with other Commission officers working on related aspects (agriculture, fisheries, etc.). Applicants must be fully qualified medical practitioners from a recognized faculty of medicine, must have completed postgraduate training in nutrition and must have had some field experience in nutrition work under tropical conditions. Fluency in English and French is very desirable. The appointment will be for three years. The commencing salary will be between £1,750 and £2,000 sterling, according to qualifications and experience, with annual increments and substantial allowances. No local income tax is payable.

Applications, supported by a detailed curriculum vitae, should be sent to the Secretary-General, South Pacific Commission, Noumea, New Caledonia.

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Applications, giving the names of two referees, should be addressed to reach the Secretary, not later than July 3, 1954.

UNIVERSITY COLLEGE OF
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Applications are invited from persons with veterinary qualifications for the post of Lecturer in Animal Physiology and Animal Health in the Department of Agriculture (Animal Husbandry). Salary according to experience and qualifications within the scale £550 to £1,100 (with an efficiency bar at £800).

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MEDICAL TECHNICIAN REQUIRED BY Ministry of Supply for Research Establishment near Salisbury, Wilt., to take charge of small clinical laboratory for haematology and general clinical observations. Minimum qualification higher school certificate or equivalent, but additionally membership of the Institute of Medical Technology desirable. Alternatively Fellowship of I.M.L.T. or Associateship, plus a period of appropriate experience. Post is graded as Assistant Experimental Officer. Salary within range £276 (age 18) to £615. Women somewhat less. This appointment is unestablished, but pensionable post exists for candidate within prescribed age limits and who is otherwise suitably qualified.—Application forms from Ministry of Labour and National Service, Technical and Scientific Register (IO), 26 King Street, London, S.W.1, quoting G.188/54A. Closing date July 3, 1954.

H.M. COLONIAL SERVICE

Applications are invited for the following post Livestock Research Officer, Eboli Livestock Experimental Station, British Guiana. Duties include the planning and supervision of research and other projects for the purpose of ascertaining the most economic methods of developing commercially-deficient savannahs of the area. Candidates should possess a good honours degree in agriculture, or the equivalent, with at least five years' postgraduate experience in field experimentation and tropical agriculture, with particular reference to pasture management at animal husbandry. Eboli is an isolated station situated about 75 miles up the Berbice River and offering virtually no opportunities for organized social life, but the living conditions are not unpleasant, and visits can be made to Headquarters at frequent intervals. Appointment on probation in the Colonial Research Service in the Principal Scientific Officer scale (£1,000 to £1,375 p.a.), plus an overseas research allowance of £250 to £170 per annum. Outfit allowance £60. Unfurnished quarters provided at a rental of 8 per cent of salary up to a maximum of £12k per annum. Free passages on appointment and on leave for officer, wife and children under 13 years of age.

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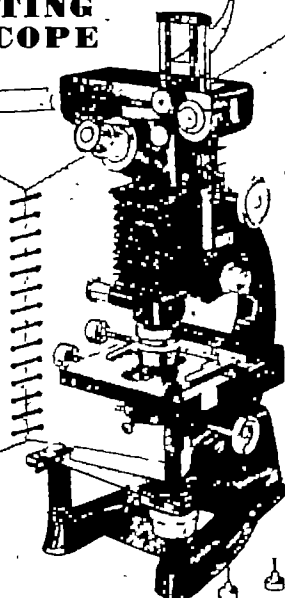
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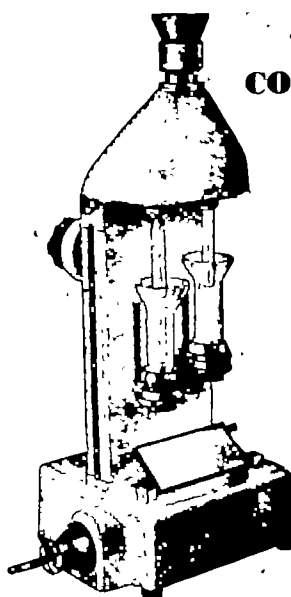
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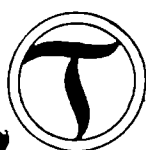
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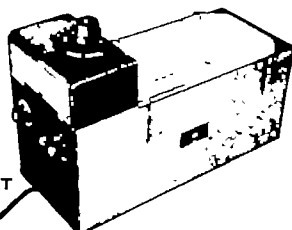
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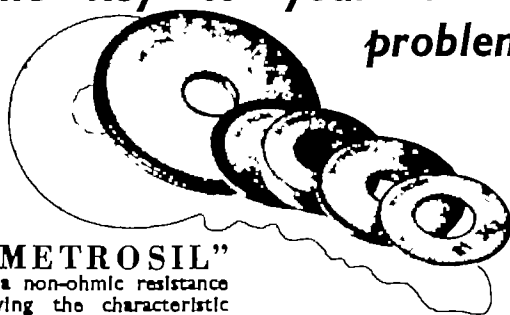
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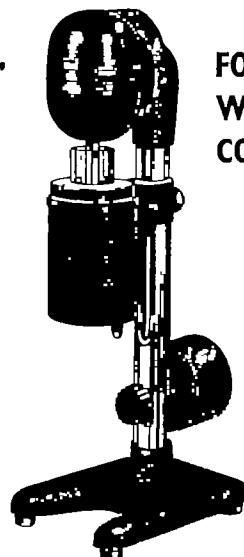
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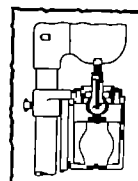
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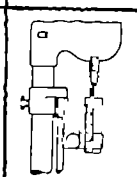
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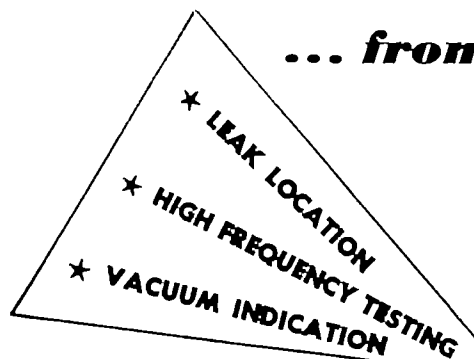


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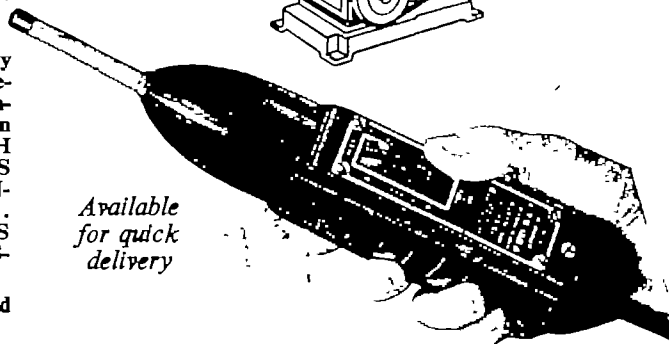
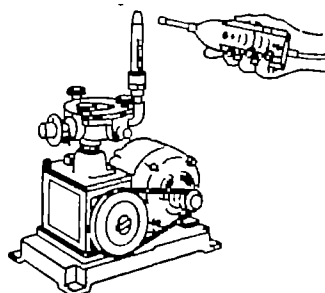
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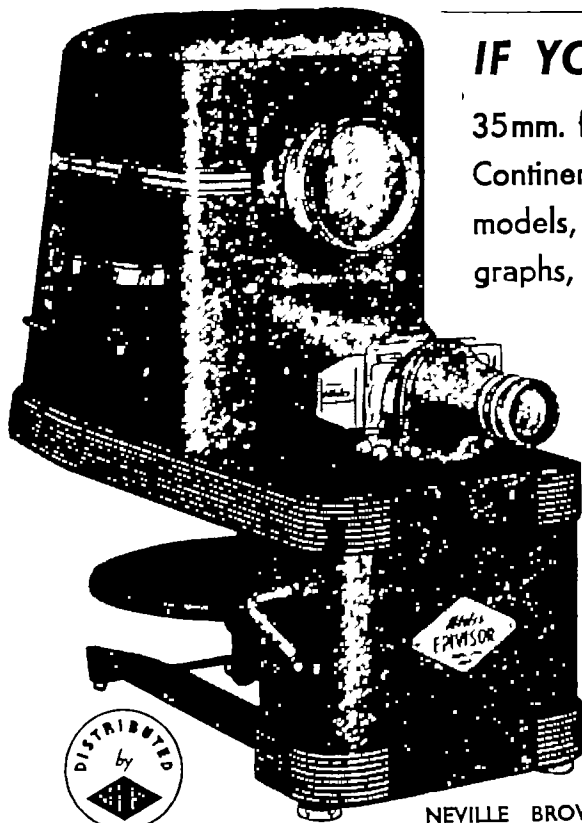


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SCIENTIFIC RESEARCH AND EXPOSITION

EFFECTIVE exposition of a scientific theme is highly important at the present day, and two recently published books* provide good examples of it. Herr Jungk's book has the narrower scope, in that he limits his survey to the American scene and describes some of the projects and achievements of American scientists in the exploration of space, the development of atomic energy, in agriculture and horticulture, the control of weather, in animal biology, industrial psychology, the electronic computer and the like. By and large, he is concerned rather to depict the actual impact of such projects and achievements on the social order, and to suggest their probable effect on the society of to-morrow. In particular, he gives a graphic picture of the changes which the atomic energy programme has already wrought in Colorado, at Los Alamos, in Nevada and elsewhere. His book is a series of snapshots of a world in which man has already changed his environment and himself, rather than of the discoveries by which man has gained such control over Nature.

Mr. Kaempffert (see also p. 1211) touches on the exploration of space, the ionosphere, weather control, supersonic flight, atomic energy, the possibilities of generating energy from the sun, advances in animal and human biology and their implication for the control or prevention of diseases like cancer, but he gives a highly skilled and readily intelligible exposition of the scientific discoveries concerned, the way they have been made and something of what they mean for mankind. Further, Mr. Kaempffert's book is not restricted to the American scene. Moreover, its clear pictures of the nature of the process of scientific discovery and the working of the scientific mind depict the scientist as a human being, whereas Herr Jungk's picture of the scientist is that of a mystery man, even one who is carrying the conquest of Nature so far as to attempt to make himself into a god. In an address to the American Association for the Advancement of Science at Philadelphia in December 1951, Prof. Kirtley Mather discussed such anti-scientific tendencies and their significance. While such trends have undoubtedly caused scientists themselves to consider more carefully the social consequences of their work, it has not been made any easier thereby for science to make its full contribution to human welfare and the practical affairs of everyday life. Indeed, as much of the discussion over the hydrogen bomb indicates, muddled thinking and a confusion of moral issues with practical affairs lead to evasion of the hard intellectual effort required to evolve adequate means of international control and co-operation, which are the real challenge of the situation.

* Tomorrow is Already Here: Scenes from a Man-Made World. By Robert Jungk. (Translated from the German by Marguerite Waldman.) Pp. 220+15 plates. (London: Rupert Hart-Davis, Ltd., 1954.) 16s. net.

Explorations in Science. By Waldemar Kaempffert. Pp. 288. (London: Victor Gollancz, Ltd., 1953.) 12s. 6d. net.

Both books, it is true, demonstrate the inescapable contact between science and politics; but whereas Herr Jungk gives no indication as to how that contact should be guided, Mr. Kaempffert shows that there is a certain amount of common ground, and that it is possible for the scientist and politician to walk together on terms of mutual respect and understanding. That is to say, Mr. Kaempffert has not stopped at exposition: he has carried his venture in communication to the point of interpretation, so that the ordinary citizen, whether politician or scientist working at some other frontier of knowledge, farmer, salesman, housewife, airman or soldier, can gain some understanding of what the scientist is doing, how he goes about his work, its implications for the world of to-day and the conditions essential for the continuance of such scientific work. In the main, this is done in the concluding three chapters of the book, in which Mr. Kaempffert explains the nature of the scientific method and its requirements, and how it is that the application of scientific discovery inevitably involves social change, paying at the same time a deserved tribute to Wells's efforts in this direction. Nevertheless, the same theme is implicit and often explicit in his accounts of particular developments in the earlier part of the book.

This interdependence of science and politics was brought out even more effectively by Prof. Kirtley Mather in his retiring presidential address to the American Association for the Advancement of Science in December 1952. That interdependence, he urged, especially the increasing dependence of fundamental science upon public funds, has made it imperative to make the common ground of science and politics more obvious, to encourage the co-operation of scientists and politicians in the service of mankind, and to eliminate recrimination and distrust. Prof. Mather referred then to the marked reluctance of scientists in the United States to enter Federal Government service, and foretold the further damage to relations between scientists and the Federal Government done by the passage of the McCarran Act by Congress over the President's veto.

On this point of the conflict between intellectual freedom, essential to scientific progress, and national security, and the contribution of the individual or minority to creative thought, Prof. Mather expounded the real issues no less vividly than Prof. A. Macbeath did in his 'plea for heretics' before the British Association at Belfast. Nor did he hesitate to insist that the ideas of competent scientists should play an effective part in determining the limits of security measures. He recognized that the removal of the present stultifying atmosphere and the acceptance of reasonable standards for scientific freedom demand a public understanding which can only come with education and the establishment of effective means of communication—interpretation as well as exposition.

That is a task of integration in which both scientists and politicians have a place. The scientist must assist in developing a climate of opinion that recognizes the supreme worth of intellectual freedom. He must resist vigorously any tendencies in education or

elsewhere that pervert democratic institutions into means for the expression of group prejudice and autocracy inimical alike to science and the general well-being.

Referring again to the books by Dr. Jungk and Mr. Kaempffert, it must be pointed out that both authors bring out very clearly the conditions of scientific advance and the grave danger to science in the United States and elsewhere arising from the real or imagined need for secrecy and its effect on the free exchange of information and ideas. Both Jungk and Kaempffert put this issue of freedom of communication, debate and discussion in its proper perspective in relation to scientific advance; and the consequences of failing to hold a reasonable balance in practice between the claims of 'security' and the exploration upon which real continuing security depends are clearly shown.

But this is only one illustration of the importance of clear interpretation of the possibilities in presenting science to the public. Interpretation is one of the most important functions in the presentation of science and the scientist has the duty at least to assist in that interpretation. But it may not succeed until the non-scientist realizes that science is not necessarily linked up with atom bombs and destruction. Neglect to carry out that task may well involve restraints on scientific work which may gravely hinder its prosecution. It may result in disastrous direction from outside or the withholding of essential funds, now increasingly drawn from public sources.

Scientific advance itself, no less than the effective application of science in industrial and national affairs, depends increasingly on the extent to which not merely the government, but also the ordinary citizens on whose support government ultimately depends in a democracy, should have some understanding of what is happening in science, an appreciation of how it can be wisely utilized and a sense of responsibility for its prosecution. That is one of the primary reasons for the concern of the scientist with the problem of education as a whole; the effectiveness of the educational system determines largely the means he must adopt to deal with his problem of communication as well as the efficiency of those means. Also, as corollary, it requires him to examine closely his objectives in this task of communication and the appropriateness of the means at his disposal.

The importance of this latter factor was well illustrated by the Reith Lectures given last year by Prof. J. R. Oppenheimer. The Reith Lectures are above all an attempt to communicate not so much information as ideas to a widespread serious and attentive audience. Their success in achieving their declared purpose is to be judged by the extent to which they stimulate thought and promote public understanding of some great issues of the day, or in other words, just that understanding and sense of responsibility upon which we have frequently insisted in respect of science.

Nevertheless, the criteria of success are not mass criteria. It is true that the Reith lecturer, like other expositors and interpreters, requires

some understanding of the outlook, the sympathies and the limitations of the ordinary folk who make up the millions of his listeners; he is equally entitled to expect of his listeners a more serious intellectual effort than would be expected of the viewer at a cinema or the ordinary television programme. Exposition and interpretation are more than entertainment. They involve co-operation, but that co-operation will only be secured if interest is aroused. The comparative failure of Prof. Oppenheimer's lectures to make any effective impact on so many of his listeners was, however, not due so much to the scientific limitations of his audience as to failure to present his theme in a setting which, by challenging and capturing the interest of his listeners, would induce them to make just the necessary effort for them to apprehend, even without a scientific or mathematical training, something of the bearing of scientific thought, and nuclear physics in particular, on the society of to-day. That it can be done Oppenheimer himself has shown, for example, in an earlier article on the encouragement of science, in which he expounded a letter of Jefferson on the relations between science and political life in a way that no hearer of the Reith Lectures could have failed to apprehend. Nor need erudition exclude either creative thought or the stimulation of healthy argument.

The Reith Lectures are not, of course, limited to the presentation of a scientific world picture, and it has to be admitted that those given by scientists have not been among the most successful. An even more serious defect, however, in another series has been the failure of the lecturer to take account of the limitations of such a vast audience, so that the picture of world history which he presented became dangerously tendentious where members of his audience did not possess the knowledge to correct the effect of deliberate or accidental omissions. None the less, such lecturers as Lord Russell, Mr. Robert Birley and Lord Radcliffe have achieved such success in stimulating thought and presenting vital issues that the possibilities of this method of communication should be fully explored and utilized, and there is every reason for believing that Sir Oliver Frank's forthcoming lectures on "Britain and the Tide of World Affairs" will touch as high a level as any of the earlier lectures.

At a time when, however, the educational and formative influence of such a new mass media as television is still a matter of discussion and experiment, and when the scarcity of science teachers in the schools threatens both the supply of scientists and the education in science of the general citizen, and especially of the leaders in all walks of life, it is well to remember that the effectiveness of the exposition of science is not set solely by the skilfulness of the expositor in presentation or interpretation. His choice of means is limited in part by the general level of education and understanding of the community in general. These are the factors which determine the amount of co-operation on which he can depend in arousing and maintaining interest. When all stress has been laid on the need for scientists

as such to address themselves much more carefully to this question of communication and presentation, to co-operate fully with those who take up this task, whether they be scientists themselves or journalists, and whether the media be the spoken, the written, or the broadcast word, or the newer visual media, it still remains true that it is in the schools that the foundations of the understanding of science must be laid. Unless the beginning made there is sound, no efforts of scientists or others in the presentation of science are likely to convey to the ordinary citizen the real understanding which he needs, of what science is, and how it can contribute to the welfare of man or, if misused, to the undoing of mankind.

THE DISPLACED SCHOLARS AND SCIENTISTS OF 1933-52

The Rescue and Achievement of Refugee Scholars
The Story of Displaced Scholars and Scientists 1933-1952. By Norman Bentwich. (Studies in Social Life—1.) Pp. xiv+108. (The Hague: Martinus Nijhoff, N.V., 1953.) 6.25 guilders.

THE story which Prof. Norman Bentwich has to tell of the refugee scholars who were displaced from the Dictator-States between the years 1933 and 1952 is brim-full of human interest. When in the former year Hitler came into power as Chancellor of the German Reich, he took advantage of the unfortunate circumstance that the universities and research institutes were in general State-owned and their staffs State officials, so that it was an easy matter to 'cleanse' such establishments by ordering that all those considered to be of other than 'Aryan' origin, or not whole-hearted Nazis, should be summarily dismissed. This led to the elimination of more than twelve hundred scholars and scientists within the next two years. Inside Germany itself, there was but little resistance to this drastic policy, and the few who objected were themselves removed. Nor was there within Germany itself any organized movement to help those thrown out; any help that did come had to be from outside.

It is in this way that the author introduces his subject, and all that happened in those critical years had a deep influence on what was to follow when the countries of eastern Europe came more and more under German control. That the institutions concerned were attached so intimately to the State would, no doubt, not have been so serious a handicap in the days when there existed many small dukedoms and principalities to which a rejected scholar could turn; but it became devastating when an all-embracing central government was in such complete control that even rectorial heads had to model themselves to behave as little 'Führers'. In fact, as was graphically said in an article in the *Universities Review* of April 1936, by Prof. A. V. Hill, Sir F. Gowland Hopkins and Sir Frederic Kenyon: "A German university under the new regime is as to the one part a regiment preparing for war, as to the other an intellectual concentration camp".

Efforts directed towards the rescue of scholarship were made in increasing degree by Western States, largely on the initiative of Great Britain, which set up, under the presidency of Lord Rutherford, an

Academic Assistance Council (succeeded a few years later by the larger "Society for the Protection of Science and Learning", which is still functioning). In 1935 the U.S.S.R. itself became one of the many States in which displaced scholars could find temporary shelter; but that did not long endure, and by 1936 there followed the forced return of almost all of them and even the imprisonment of some. By this time the number displaced from the German universities had risen to seventeen hundred, and their conditions of life became steadily worse. (Although China in its turn became another source of academic exiles, this chiefly concerned the student body and is therefore not included in Prof. Bentwich's survey; it was looked after by the International Student Service with a centre in Geneva.)

The Nazi attack on scholars in Austria and Italy in 1938 led to the displacement of a further five hundred university teachers and scholars. Here again, willing help was given by Britain to the victims; but with the outbreak of the Second World War it was realized that private aid could not carry so heavy a burden by itself and that the British Government must needs shoulder a large portion of it. As the war area spread, other Western European countries suffered in much the same way, and if the means of escape became harder the ingenuity employed became greater: the famous scientist, Niels Bohr, had to get away in a fishing boat at night.

By 1945 the total number of academic refugees registered by the Society for the Protection of Science and Learning rose to more than twenty-five hundred; of those, about half were from Germany and the rest from other European countries. In Britain and the United States the number each received was more than six hundred, most of whom have since become part of the scholarly groups in those two countries.

When Hitler began this cruel and foolish attack on German scientists, he is reported to have said: "If the dismissal of Jewish scientists means the annihilation of contemporary German science, we shall do without science for a few years". Seven years later Sir Winston Churchill thus assessed the fatal consequence: "Since the Germans drove the Jews out of Germany . . . our science is definitely ahead of theirs"; this is graphically epitomized by Prof. Bentwich as "the Nemesis which attended the National Hubris of the Nazis".

In an eloquent epilogue, Prof. A. V. Hill sums up the story of those hard days: the Academic Assistance Council, he says, had no partisan, political or national bias, and indiscriminate relief was no part of its work. "Its purpose was to act as a link between the scientific workers and other scholars displaced and the universities and research institutions of the world, so that their exceptional abilities exceptionally trained—to quote the noble declaration of the Council's founders—should not be lost". Those who took part in it may well be moved with pride—and humility—when reminded by some friend of the many perils in which scholarship then stood and how the danger had been alleviated by the sympathy and generosity of fellow workers in the West.

Prof. Bentwich aims also at the inclusion of some account of the subsequent achievements of the refugee scholars; but it may be questioned whether this is really necessary. The qualities of the men and the response they naturally made to the opportunities of work opened so gladly to them tell unaided their own story.

H. E. WIMPERIS

MALAYAN ORCHIDS

A Revised Flora of Malaya

An Illustrated Systematic Account of the Malayan Flora, Including Commonly Cultivated Plants. Vol. 1: Orchids of Malaya. By Prof. R. E. Holttum. Pp. v+753+4 plates. (Singapore: Government Printing Office, 1953.) 20 Malayan dollars.

THE continuous advance in our knowledge of the floras of the world renders necessary the appearance at intervals of summations of that knowledge, either in the form of monographic studies of natural groups of plants, or of Floras of various geographical regions. One region in which a new presentation of our knowledge is required is Malaya, since Ridley's "Flora of the Malay Peninsula" was published about thirty years ago and, moreover, was to a considerable extent based on insufficient data.

The appearance of the first volume of a new Flora of this region is therefore to be welcomed, and it is a happy choice that this volume should deal with the Orchidaceae, a family of outstanding interest both to the scientific botanist and to the plant lover. Prof. R. E. Holttum has long been interested in these plants; but it was only during the war-time occupation of Singapore by the Japanese that he perforce had the leisure in which to carry out the work necessary for the preparation of the present book.

Apart from botanical exploration in Malaya itself since the publication of Ridley's Flora and the incorporation of the results into a new Flora, it has been essential to consider the Malayan orchids in the light of the extensive researches carried out by the late Dr. J. J. Smith on the orchids of the Malaysian region in general. Smith's work is of fundamental importance in the study of the orchids of this region, and the application of the results of his researches to the Malayan orchids has necessitated many changes from the names and classification in Ridley's account.

Most Floras include, in addition to the native species, a selection of the more important established aliens, but Prof. Holttum breaks new ground by including accounts of the genera, species and hybrids more generally cultivated in Malaya. This renders the book of interest to orchid growers as well and permits of a wider treatment of genera and sub-generic groups. This is advantageous when the cultivated plants are of Malaysian origin, since the native orchids of Malaya are a rather scrappy selection of the total Indo-Malaysian orchid flora. The inclusion of American and African groups and genera is less satisfactory. It is impossible in the space available to deal with these groups adequately, though it must be confessed that the author has provided much useful information. The writer is somewhat sceptical, however, of the possibility of naming with certainty many of these exotic orchids from the data provided; moreover, the introduction of new species and the continuous production of new hybrids will fairly soon render this part of the account out of date.

The numerous keys to the genera, parts of genera, and species form one of the very useful features of the book. These are of particular importance in the large genera, like *Dendrobium*, *Bulbophyllum* and *Eria*, as some of these sectional groups have never been distinguished in this clear manner before. Prof. Holttum takes, on the whole, a rather conservative attitude towards genera, but gives full weight to modern work on the Malaysian monopodial orchids,

in which several of the cumbersome genera have been divided into more natural groups. An excellent key to the genera of this group is provided, based mainly on J. J. Smith's work.

The book is illustrated by four attractive colour-plates of hybrids and more than 230 line-drawings, mostly from the pen of the author. These are especially valuable in showing the diagnostic features of the species and genera figured, besides supplementing the very clear descriptions. For the orchid grower in the tropics there are introductory chapters on the cultivation both of adult plants and of seedlings and, for orchid growers in general, excellent accounts of the main hybrid groups which have been developed in tropical countries. These include *Spathoglottis*, *Dendrobium* and the numerous bigeneric hybrids belonging to the large monopodial group. The latest results are here brought together by one who has been closely associated with much of this hybridization in recent years.

Altogether Prof. Holttum's book provides a very satisfying account of the orchids of Malaya, and will no doubt for long be the standard reference book on this subject.

V. S. SUMMERHAYES

THE ROTHSCHILD COLLECTION OF FLEAS

An Illustrated Catalogue of the Rothschild Collection of Fleas (Siphonaptera)

in the British Museum (Natural History), with Keys and Short Descriptions for the Identification of Families, Genera, Species and Subspecies. By G. H. E. Hopkins and Miriam Rothschild. Vol. 1: Tungidae and Pulicidae. Pp. xv+361+45 plates. (London: British Museum (Natural History), 1953.) 84s.

ALTHOUGH one of the 'smaller orders' of insects (about 1,350 described species and sub-species), the Siphonaptera, or fleas, are the subject of a considerable volume of taxonomic literature, mostly written during the past half-century, or since the role of some species as vectors of bubonic plague was proved. A world list published in 1895 included only thirty-five species. About that time, three entomologists, Julius Wagner in Russia, Carl F. Baker in the United States, and the Hon. N. Charles Rothschild in England, turned their attentions to this virtually neglected group of small and despised insects. All three left their mark in flea taxonomy; but it was Rothschild who amassed what is even to-day the world's most representative collection. Working at first alone but later with his friend and colleague Karl Jordan, Rothschild published numerous descriptions of genera and species that set a standard of definition and accuracy not often excelled to-day. At an early stage Rothschild realized the importance of the collection he was building, and by deed of gift in 1913 arranged that it become the property of the British Museum (Natural History) on his death. According to one of the provisions of the deed, the trustees were to "cause to be made and published a catalogue giving the names and full number of specimens of each species of parasitic insect in the said collection".

The collection became the property of the Museum in 1923, on Rothschild's death; but thirty years were to elapse before the catalogue could be prepared.

The delay has been advantageous in many ways: the collection has continued to grow; numerous new species, genera and other categories have been described; and most important, Karl Jordan, the greatest authority on the order, has had time to study the difficult problems of phylogeny, which had to be considered before a natural classification could be proposed, a task that would have been impractical three decades ago.

The book under review, then, is the first volume (of five) of the promised catalogue, and is the work of G. H. E. Hopkins and the Hon. Miriam Rothschild (daughter of Charles). The authors set themselves three objectives: to fulfil the terms of the deed of gift; to provide keys, descriptive notes and figures to aid in the identification of all known species; and to publish the skeleton classification made by Dr. Jordan. Despite their modest assertions to the contrary, this work will virtually constitute a monograph of the Siphonaptera of the world.

A preface and foreword are followed by an introduction, which defines the scope of the catalogue and gives some particulars about the collection, which now contains about eleven hundred, or more than 80 per cent, of the known species and sub-species, including 682 holotypes and lectotypes of valid forms, as well as numerous paratypes, and types of synonyms.

Of great interest are the provisional phylogenetic tree illustrating Jordan's views on the broad relationships of the seventeen families of fleas, and a table of the valid genera and subgenera, which number about two hundred, with their families and sub-families. An illustrated and annotated glossary, covering twenty pages, will prove most useful, as there has been much non-conformity in interpretation and terminology of flea anatomy; the usage in the present catalogue is therefore defined. This section is followed by keys and the main body of the text.

The authors follow Jordan (1948, in Smart) in considering the Siphonaptera as divisible into two superfamilies, the Pulicoidea (the smaller, and the topic of Vol. 1) and the Ceratophylloidea. The Pulicoidea contain two families, the Tungidae (sub-families Tunginae and Hectopsyllinae) and the Pulicidae (Pulicinae, Archaeopsyllinae, Spilopsyllinae and Xenopsyllinae). In all, 24 genera and 147 species and sub-species are considered to belong to the Pulicoidea. Adequate keys (tested by the reviewer on specimens of about sixty species) and concise descriptions are provided for all categories. The important but difficult genus *Xenopsylla* (fifty-seven species) is broken down into eight species-groups. Locality and host records are limited to material in the collection and examined by the authors. These are arranged geographically according to the regions and sub-regions defined in Bartholomew, Eagle Clarke and Grimshaw's "Atlas of Zoogeography" (1911), an arrangement that is satisfactory for the purposes of the catalogue. Host nomenclature has been revised to conform with the recent works of Ellerman, Peters and others. There is little or no discussion of host relationships or geographical distribution *per se*.

The book is profusely illustrated by line-drawings of the diagnostic structures of the species. There is some lack of uniformity in the figures in that they were prepared by a number of individuals; but they have been well selected and a high standard of quality has been maintained. Forty-five plates of

truly excellent photographs of fleas deserve special mention. These are mostly the work of Arthur Barron and are quite the best and most useful photographs of fleas I have seen. It is to be hoped that the succeeding volumes will be similarly illustrated.

It is understood that Vol. 2, covering seven families (Coptosyllidae, Vermipsyllidae, Stephanoceroidea, Hypeophthalmidae, Ichnopsyllidae, Macroscyllidae and Xiphiopsyllidae) of the Ceratophylloidea is due for publication. The appearance of this and succeeding volumes will be eagerly awaited by all students of fleas. Meanwhile, the authors and publisher may be congratulated on the high quality and practical usefulness of the first volume of a work that will be the standard reference on fleas for many years to come.

G. P. HOLLAND

MATHEMATICAL METHODS

Methods of Theoretical Physics

By Prof. Philip M. Morse and Prof. Herman Feshbach. (International Series in Pure and Applied Physics.) Part 1: Chapters 1 to 8. Pp. xxii+998+xl. Part 2: Chapters 9 to 13. Pp. xviii+999-1978. (London: McGraw-Hill Publishing Company, Ltd., 1953.) 120s. each volume.

THEORETICAL physics to-day has a vast content. To expound fully the mathematical methods which are necessary for the development of the major branches of the subject would be a great undertaking. Authors of text-books on the methods of theoretical physics must therefore choose between covering a very wide variety of methods in a superficial kind of way, and treating a restricted range of topics comprehensively. It is this latter course which Profs. Morse and Feshbach adopt. Despite its general title and its great length, their work consists almost entirely of an exposition of the methods of solving Laplace's equation, Schrödinger's equation, and the scalar wave equation. It is, however, an excellent account of these topics and will doubtless become a standard work.

The first three chapters of Part 1 consist of an account of various types of field (scalar, vector, tensor) occurring in theoretical physics, and of the differential equations and variational principles governing them. This is followed by three chapters on functions of a complex variable, ordinary differential equations and the theory of eigenfunctions, respectively. A great deal of the material in these first six chapters (covering nearly eight hundred pages) is familiar, but it is discussed in a manner particularly suited to the needs of the mathematical physicist. The treatment is always interesting, and sometimes novel—for example, the discussion of the 'Euler' transform in Chapter 5. The last two chapters of the first volume are devoted to the Green's function technique for the solution of partial differential equations, and to the theory of integral equations. The account of the method of Green's functions is particularly clear and attractive.

The second volume begins with an account of the three main approximate methods of solution of boundary value problems in physics: (1) the perturbation method, (2) the variational method, (3) the variation-iterational method. That this chapter is long (more than 170 pages), and difficult, is due largely to the fact that the authors have illustrated

the methods they describe by applying them to difficult and worth-while problems of the kind which a theoretician will encounter in the course of his researches, rather than to the artificial kind of problem one encounters all too often in mathematical treatises. The remainder of the work is devoted to the application of the principles already established to the differential equations of mathematical physics—Laplace's and Poisson's equations, the wave equation, the diffusion equation, Schrödinger's equation. The partial differential equation approach (separable systems) is developed for exact solutions, the integral equation approach for approximate solutions.

From this brief description of the contents of the book it will be seen that it is, as the authors state in the preface, more a treatise on the boundary value problems of mathematical physics than a comprehensive account of mathematical methods. For example, it treats very sketchily, or omits entirely, the theory of characteristics, the flow of fluids, supersonic flow, and the equations governing the behaviour of solid continua. It does not develop either the theory of groups or the theory of matrices, both of which are of great use in theoretical physics. Nor is the use of dyadics rather than tensors a very happy choice. But within their limited field the authors have produced a work which, both on account of the amount of physics and the rigour of the mathematics, is very nearly complete and self-contained.

The striking feature of the whole work is the clarity of the exposition. Difficulties are not avoided or treated superficially. Little attempt has been made to compress the material; this may have led to a book of great length, but it has also produced one of great value. As has already been indicated, the physical problems which the authors discuss have been chosen for their current interest, and are seldom trivial. No attempt has been made to produce solutions from 'thin air'—the problems are tackled in a systematic way which not only illustrates the basic points of the theory, but also helps the young research worker to acquire a body of technique sufficient to enable him to grapple with the problems he encounters in the course of his researches. Running through the book is the view that very few problems in mathematical physics are capable of exact solution, so that the student must acquire facility in deriving approximate solutions. The approximate methods which the authors develop are analytical in nature. The fact that they do not discuss purely numerical techniques, such as 'relaxation', is not a serious drawback, since there are already in existence several admirable accounts of these methods.

The standard of book production is well up to the excellence of the authors' writing. The printing, the lay-out and the illustrations of the book are of an exceptionally high quality, and make it a pleasure to use. The book's one disadvantage is one which will not have escaped the publishers: its high price (£12 for two volumes) makes it impossible for all but a very few students to possess it. It is difficult to see how a book of this length could have been other than expensive; but it is a pity that it cannot be readily available to students. It should, of course, be in the library of every mathematical department. It will not lie undisturbed upon the shelves, for it contains a very great deal which will be of value to all who have to learn (or have to teach) mathematical physics.

I. N. SNEEDON

The Yearbook of the Universities of the Commonwealth, 1954

Edited by Dr. J. F. Foster. (Thirty-first issue.) Pp. lviii+1916. (London: Association of Universities of the British Commonwealth, 1954.) 63s.

ONCE again the Association of Universities of the British Commonwealth has produced its "Yearbook". This year's edition is more than a hundred pages longer than the last one, but remains at the same price.

The only additional complete entry for an institution this year is the Nova Scotia Agricultural College; but mention is made of the establishment in July 1953 of a second university in East Pakistan, the University of Rajshahi, and of Rhodesia University College, Salisbury, and it is hoped to have full entries for these in next year's edition. Of the other new material, the introduction for the universities in Australia has been specially rewritten by the Secretary of the Australian Vice-Chancellor's Committee, and a fuller statement is included of the history and functions of the Association of Universities of the British Commonwealth. In addition, an attempt has been made for the first time this year to give for each university and university college in the United Kingdom a short statistical note of the numbers of its students who come from other countries.

Besides the various national sections with the staff lists for each of their university institutions, the usual host of information is to be found in the nine appendixes. The alphabetical list of names contains more than thirty thousand entries. Once again the important point must be emphasized that this book records all the university institutions of the British Commonwealth and not merely those—the majority, in fact—that are members of the Association of Universities of the British Commonwealth. Indeed, in one of the appendixes are the respective lists for the universities in the Republic of Ireland. The point is well made in the preface that, although this book is not international in the comprehensive world-wide sense, it covers such a large part of the globe and includes such a diversity of countries and races that it must surely rank as one of the leading international works of reference about universities.

Vulkanismus und andere Tiefenkräfte der Erde

Von Carl Chr. Beringer. (Kosmos Bändchen No. 200.) Pp. 64. (Stuttgart: Kosmos-Gesellschaft der Naturfreunde, 1953.) n.p.

THIS booklet is one of a series designed to make a popular appeal to various subjects in science and natural history. The title is somewhat misleading, since the first fifty-two of its sixty-four pages are devoted entirely to a condensed account of the main modern volcanic eruptions, their types and distribution. It is well illustrated with plates and diagrams, though the map of the world (frontispiece) oddly omits the British Isles. The phenomena of fissure-eruptions, plateau-basalts and pillow-lavas receive but scant attention, and the relationship of the acid or basic composition of the lavas to the types of eruption is not made clear.

The second part of the book, which attempts to deal with the other deep-seated agencies in the earth's crust in a dozen pages, not unnaturally fails. It includes a short description of bathyliths, the hypothesis of shells surrounding a nickel-iron core and a note on supposed convection currents within

it; the barest mention of continental drift, radioactivity, geosynclines, orogeny and earthquakes; and expresses the belief that volcanic activity is steadily waning through the passage of geological time.

The bibliography contains a list of seventeen authors, seven of them in the nineteenth century from 1808 upwards; the only reference in English is dated 1825. Surely in 1953 a representative and up-to-date conspectus of the principal literature could have been included?

The booklet is well printed in Roman characters, on paper which seems equally suitable for text and plates. It would serve its purpose far better were the title restricted to vulcanology with more generous treatment, while discarding the unsatisfactory tail-piece. This could well be developed into a companion volume on geophysics and dynamics.

D. W. BISHOPP

From an Antique Land

Ancient and Modern in the Middle East. By Dr. Julian Huxley. Pp. 310+49 plates. (London: Max Parrish and Co., Ltd., 1954.) 25s. net.

THIS is a delightful book and as a record of travel in the post-war Middle East is outstanding in its merits. The author, travelling on the affairs of Unesco, visited and recorded his impressions of nearly every place of importance which is readily accessible. Even places with which a reader is perhaps very familiar assume a new interest when viewed through the author's inquiring eyes; and almost equally so when seen through the lens of his camera. The photographic illustrations, many of them in colour, are superb, and we can only regret that there are not more of them.

In his introduction, the author modestly claims that even after his wide and hurried travels and his study of the works of authorities, his knowledge remains "extremely scrappy". If this is so, his marshalling and analysis of his scrappy knowledge is most satisfactory; and his chapter on the birth of civilization is, in the writer's view, masterly. It is only when we read an essay such as this that we can fully realize the vast accumulation of historical fact that has been laid bare by the archaeologist during the past half-century.

To any prospective traveller in the Middle East countries, this book should prove invaluable reading prior to his journey; and even more interesting entertainment on his return.

W. B. EMBRY

Metallurgical Abstracts

(General and Non-Ferrous). Edited by N. B. Vaughan. Vol. 18, 1950-51 (New Series). Pp. viii+925. (London: Institute of Metals, 1951.)

THIS volume for 1950-51 of "Metallurgical Abstracts" maintains the high standard set by the Institute of Metals and should be invaluable to all metallurgists. The writing is in general clear and good; but more concise phrasing would result in a saving of several lines per page without any loss of subject-matter, and would avoid the necessity of unpleasant abbreviations, such as 'temp.' for temperature, which spoil the appearance of the volume. It may be suggested that, in view of the knowledge of English in so many countries, the abstracts would be of more value if a greater proportion of the space were given to the more important papers in the obscurer languages.

W. HUMPHREY

CHANGES IN WORLD GLACIATION

A GEOPHYSICAL Discussion of the Royal Astronomical Society in conjunction with the British Glaciological Society was held at Burlington House, London, on January 29, the subject being "Changes in World Glaciation". The principal speakers were as follow: Prof. F. E. Zeuner (Institute of Archaeology, University of London), Dr. J. D. H. Wiseman (British Museum (Natural History), London), Prof. G. Manley (Bedford College, London) and Mr. F. Hoyle (St. John's College, Cambridge), in that order. Mr. Gerald Seligman, president of the British Glaciological Society, was in the chair.

Without doubt such a subject of discussion ranks with several others of a cheerfully provocative kind in which it is not given to any one group of scientists to provide the answer. In a sense, such major issues offer not only a meeting-ground but also a much-welcomed stimulus. It has long been proverbial that he who wants to set a university by the ears with the view of encouraging the students can scarcely do better than arrange a symposium on such subjects as submarine canyons or cloud physics. In a symposium on climatic change the geologist busy with his muds lifts his eyes again to the stars; the astronomer is suddenly reminded that he must bring down his time-scale to cope with the mundane requirements of the botanist; the environmental archaeologist seeks more fundamental reasons for the pathetic squalor of his kitchen-middens. The physicist is led to reconsider the yielding of masses of ice under varying conditions of temperature; and the meteorologist, eternally distracted by the hourly irregularities of his elusive goddess, begins to wonder whether her pattern of behaviour can be led to display a major alteration through gentle persuasion or through sudden blows.

Opening the meeting, Mr. Seligman referred to the need for further work on the causes of changes in world glaciation, whether within the earth's system or without, and directed attention to Dr. H. W. Ahlmann's emphasis on the great value of such studies in the interrelation of the sciences. A large and highly diversified audience attended; but it became evident that co-ordination of the approaches made by workers in several fields is still not easy, and a two-hour meeting on such a vast subject could but leave the appetite whetted.

Prof. Zeuner began by very appropriately stressing the need for further collection of facts. He believed that the integration of evidence both in space and time is first necessary, and the new techniques of dating successions for purposes of correlation are still in an early stage. He demonstrated the complexity of the problem of glaciation in relation to the evidence for eustatic changes of sea-level in the Pleistocene in those areas which might reasonably be deemed free of isostatic complications. Quite apart from the effects of the several successive phases of the Ice Age, there appears to have been an overall lowering of sea-level during the past million years or so throughout southern and south-western Europe. If that is so, the relationships between large-scale terrestrial changes, presumably of tectonic origin, and glaciation is not simple and requires further elucidation. With the aid of a diagram he pointed out that in the Post-Glacial the prevailing rate of

fall of sea-level relative to the land underwent what might perhaps be rhythmic fluctuations with a period of the order of 1,800-2,000 years, a fact deduced from close studies of the Thames terraces and of numerous beach-levels. The relationship of such fluctuations to variations in the tectonic forces at work or to variation in the rate of melting of ice-caps is still open to discussion.

Dr. Wiseman gave a brief but critical account of the recent results he and his colleagues have obtained from a close study of cores, collected in the equatorial Atlantic Ocean by the Swedish Deep-Sea Expedition, 1947-48, under the leadership of Prof. Hans Pettersson. Although Dr. Wiseman has recently published a preliminary paper², work is still in progress and some exciting glimpses of these new results were given to the meeting. It is apparently possible, in suitable deep-sea cores where specified conditions have been satisfied, to determine the past temperature changes in the upper layer of the sea by three different methods.

The first method is to determine the mass contribution of calcium carbonate per c.c. per year in a series of sections throughout the length of the core; the second method is to determine the species distribution of planktonic foraminifera; and the third to determine the oxygen-18 content in specific planktonic foraminifera. A core nearly 14½ m. in length has been investigated at every 5 cm., and more detailed investigations have been carried out on a series of sections taken continuously down a short pilot core. The graph showing the yearly mass of calcium carbonate deposited per c.c. in the short pilot core shows a series of minor oscillations superimposed on a major curve. There is an apparent correlation between these minor oscillations and the known minor climatic oscillations of more temperate regions. Dr. Wiseman pointed out that the conclusions arrived at from the rate of sedimentation of calcium carbonate were supported by the species distribution of planktonic foraminifera as well as by the oxygen-18 determinations on specific planktonic species carried out by Dr. Emiliani. For example, where the yearly rate of sedimentation of calcium carbonate is relatively high—namely, 990 µgm./sq. cm.—the calcareous tests of *Globigerinoides sacculifera* were apparently deposited at 24.8° C., while at a depth of 26.3 cm. from the top of the core where the yearly rate of sedimentation of calcium carbonate has fallen to 330 µgm./sq. cm. the tests of *Globigerinoides sacculifera* were deposited at 20.1° C.

Dr. Wiseman has found it possible to make age determinations by three different methods. The sources of error were briefly mentioned, and much work has and is still being carried out to show the justification of certain basic assumptions. It is of great interest to note that the minor oscillations in the rate of sedimentation of calcium carbonate are apparently synchronous with the minor climatic oscillations of more temperate latitudes. For example, at a depth of 22.4 cm. corresponding to an age of 9300 B.C., there is a minor oscillation in the rate of sedimentation of calcium carbonate. This oscillation would seem to be synchronous with the Allerød oscillation in Denmark⁴, the age of which

according to recent carbon-14 measurements is 8800-9900 B.C.

Dr. Wiseman stressed the necessity for more work of this nature, and was careful to point out that the techniques used are not applicable to all cores, but can only be used where suitable conditions of sedimentation have existed. Finally, he showed a chart giving the many localities in the Atlantic where foraminiferal analysis has revealed cooler conditions in the past in the upper layer of the sea; and he pointed out that in four nearby cores collected from the Equatorial Atlantic, Dr. D. B. Ericson⁸ has recently been able to make correlations from core to core and has concluded that the deposition is continuous and normal, and that there is no obvious evidence of turbidity currents, erosion, slumping or re-worked older sediments.

Prof. Manley emphasized the need for more attention not to the mere existence of ice but to the changes in its extent. Referring to the advances and retreats during the past three centuries, it is clear that a marked degree of parallelism existed around the North Atlantic, shown by the series of curves from numerous sources in several countries which have been assembled by Dr. H. W. Ahlmann in his recent Bowman Lecture⁹. With a further diagram he showed that the overall agreement between the fluctuations of the southern Icelandic glaciers and what is known of the fluctuations of the mean summer temperature in England¹⁰ is temptingly attractive. The eccentric position of the Pleistocene glaciation in the northern hemisphere on either side of the Atlantic suggests that the key to the greater events of the past may well lie in studies around that ocean. Whatever other causes are sought, changes in the configuration, depth and surface temperature of the North Atlantic are still deserving of further consideration, and Prof. Manley said that he was glad Prof. Zeuner had directed attention to the same problem in another way. He went on to demonstrate the minor irregular fluctuations of the order of two to three decades in length which have also been recognized in tree-ring series and other annual deposits. While these may reflect small changes in the character of the general circulation of the atmosphere, they have all occurred in the presence of a warm North Atlantic. The greater phenomena of the past and especially the low snow-line in the Ice Age require a much cooler ocean off north-western Europe⁷; and, as the development of the greater glaciations took a long time, perhaps of the order of two to three thousand years, the sea surface must have been cooled well before the maximum of glaciation, and we should decide how this could happen. He gave reasons for the opinion that each of the minor Late-Glacial re-advances in Britain was preceded by a fall of temperature of the same order as that which sufficed for the maintenance of maximum glaciation, but lasting for a much shorter time. A very rough calculation based on the size of the revived Post-Altered glaciers in the Lake District in England appears to indicate that fifty to a hundred years would suffice for the re-advance, after which the ice lasted for four centuries or so. It would therefore appear that each of the changes in glaciation represented by advance could have taken place relatively rapidly and that they were succeeded by a much longer stage of stagnation or slow retreat. If that were so, we are faced with the problem of explaining why the pattern of the world's atmospheric circulation could be displaced, or biased,

from its present state for varying lengths of time, and why patterns which are now merely ephemeral could become more persistent.

Mr. Hoyle developed a new line; he thought that the change in the amount and character of world glaciation in the period from the Late-Glacial to the Climatic Optimum represents a climatic change so remarkable as to be outside the operation of the earth's meteorological system. Astronomers are not happy about such rapid changes in solar variation, and he referred to the other type of external influence which might result from local variations in the density of interstellar matter between sun and earth. Such effects, which he had outlined in earlier discussions¹¹, are now calculable and cannot now be allowed as sufficient. Solar radiation might otherwise become intensified by the picking-up by the sun of material from interstellar clouds; but as the sun would need to move very slowly through such clouds it would not be able to do so sufficiently often to explain the observed effects. He thought that the recent work by Dr. E. G. Bowen in Australia¹² reopens the position completely. Bowen has studied the remarkable tendency for intensification of rainfall on certain days of the year in Australia; this is now confirmed elsewhere in the southern hemisphere, and also in Britain, and it is also related to the observations of noctilucent clouds. The possibility exists that this results from the provision of nuclei arising from the incidence of showers of meteoric dust at particular seasons and falling to the right levels. Mr. Hoyle therefore suggested that one of the most satisfactory ways of changing climate would be to tamper with the 'greenhouse effect' through knocking out some of the water vapour; and that the necessary material might be provided by the breaking-up of a particularly large comet. The figures for the mean mass of comets are, he said, in agreement with this possibility, and the particles providing the zodiacal light are of the right size. Alternative explanation can still be sought in changes of the rate of movement of a gas passing through the solar system.

Subsequent speakers were much exercised by Mr. Hoyle's suggestions, and Mr. D. J. Schove asked if any evidence could be obtained from deep-sea sediments of variations in the abundance of such meteoric material. Dr. Wiseman replied that work is in progress on the nickel and cobalt content of deep-sea cores, and it is hoped that it will shortly be possible to decide whether the nickel was or was not of cosmic origin. Mr. E. Gold asked if anything is known of the effects of other meteoric streams—for example, those in August—and thought there is very little water vapour at the great heights mentioned; Mr. Hoyle thought that the time of sinking of the fine particles through the atmosphere might vary and could be of the order of twenty days.

The discussion was perforce, like many of its kind, inconclusive; but the numerous problems brought to light go far to show that although the issues are being gradually narrowed we still need more exact knowledge of what we are trying to explain; and, indeed, the problem of climatic change is increasing in complexity. Prof. Zeuner's contribution calls to mind the need to avoid the uncritical reliance on the results of changes in the extent of land and sea and of the relief in high latitudes; subsequent re-emphasis of the character of the open North Atlantic in relation to the location of the continental ice-sheets raises the question of how, and over what

length of time, cooling took place, an answer to which must await the work of Dr. Wiesman and his colleagues. There is evident need for further investigation of the extremes of climatic displacement which have resulted at various times in different parts of the world. The fact of the snow-line having been by no means uniformly lowered over the world as a whole, and the very variable length of the glacial phases, needs further study. The meteorologist is well capable of outlining pressure maps for the Ice Age; the importance now lies in the process by which transition was effected, and further evidence, from the field sciences, of the time required for such transitions may enable the meteorologist to provide an answer. The challenge of Mr. Hoyle's statement, that the change from Glacial to Climatic Optimum lies outside the operation of the earth's meteorological system, is one which will unquestionably stimulate further thought. Even the man of science on his Alpine holiday can reflect upon the conspicuous results of the seventy-odd years of decline of the Rhône glacier as a possible portent.

GORDON MANLEY

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- ⁷ Manley, G., *Geogr. J.*, 117, 43 (1951).
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NEW INSTITUTE OF CLINICAL SCIENCE AT THE QUEEN'S UNIVERSITY, BELFAST

THE Institute of Clinical Science of the Belfast Medical School was opened recently on behalf of the Duchess of Gloucester by Lord Wakehurst, the Governor of Northern Ireland. The purpose of the

new Institute is to provide additional room for teaching and to increase the research facilities of the school. Owing to certain building restrictions, it was necessary to divide the building so that the Institute consists of two buildings united by a closed-in bridge.

The west block contains two large lecture theatres capable of seating 282 and 221. In these, special attention has been given to acoustics, and a very efficient and pleasing result has been obtained. They are mechanically ventilated and furnished with modern projection apparatus of various types. Teaching facilities are also supplied in eight tutorial rooms, each capable of seating thirty students, and furnished with projection and other apparatus for demonstration. The west block also contains the Departments of Therapeutics, Obstetrics and Gynaecology, Child Health and Social and Preventive Medicine, as well as a photographic unit and an artist's studio.

The Medical Library is also in the west block. It has been provided as a War memorial, and in addition to the main reading rooms has three separate reading rooms for undergraduates, postgraduates and staff, which serve as memorials to three young graduates who fell in the Second World War. These rooms are panelled in various woods, and the main room contains six paintings by Mr. Norman Wilkinson, depicting the counties of Northern Ireland. This building is linked to the Institute of Pathology and to the teaching wards of the Royal Victoria Hospital.

The east block contains the Departments of Medicine and Surgery. The third floor is designed for experimental research. Each member of staff has a private laboratory, while in addition each department has at least one communal laboratory. A great deal of thought has been given to the services for the whole building, and these are earned in the ceilings of the corridors; but they are readily accessible above the false ceilings and can be easily expanded to meet further developments. This distribution of the services renders maintenance a relatively easy matter.

The link with the hospital, and the provision of lifts, render it possible for a patient in bed to be wheeled to any floor for detailed investigation.



The architects have been successful in producing a pleasing exterior by using multicoloured Ravenhead russet brick and Portland stone. The windows, which are double for heat conservation, are in good proportion to the mass of the building. In all, the architects have succeeded in their aim and have provided a dignified building for the undergraduate, and excellent accommodation and facilities for the research work of the staff.

THE TWO VISCOSITIES OF FLUIDS

A ROYAL SOCIETY discussion on "The First and Second Viscosities of Fluids" was held in the rooms of the Society, Burlington House, on April 29.

The discussion was opened by Prof. L. Rosenhead (Liverpool), who reviewed the fundamental facts and concepts. The generally assumed relationships between the stresses and rates of deformation in a homogeneous fluid lead to equations such as:

$$p_{xx} = -p + \mu \left(\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} \right) + 2\mu' \frac{\partial u}{\partial x} \quad (1)$$

$$p_{yz} = \mu \left(\frac{\partial v}{\partial z} + \frac{\partial w}{\partial y} \right), \quad (2)$$

where u , v and w are the components of velocity referred to fixed orthogonal axes Ox , Oy , Oz ; p_{xx} , p_{yz} components of the stress tensor, μ the first (or shear) coefficient of viscosity and μ' the second (or dilatational) coefficient of viscosity. The combination $(\mu' + \frac{1}{3}\mu)$, denoted by κ , is the bulk viscosity.

The physical meaning of μ is evident from equation (2), but that of μ' depends on the interpretation of p in equation (1). In the past the bulk viscosity has either been ignored, for which there is some justification if incompressible fluids are being considered, or it has been assumed to be zero, which is true if p is equal to $-(p_{xx} + p_{yy} + p_{zz})/3$. If, however, p is not equal to this last expression, there is no *a priori* reason for assuming $\kappa = 0$, and its actual value (and hence the value of μ') is open to experimental investigation for any given interpretation of p . Up to the present, the value of κ has not been measured directly, but values of κ/μ have been deduced independently from the results of two different types of experiment—the absorption of sound-energy and the determination of the speed of acoustic streaming. In both cases p is taken as the thermodynamic pressure, defined at constant entropy as a function of ρ . The former type of experiment is well established, but the latter field was opened up recently by the theory of Eckart¹ and the experiments of Liebermann². Liebermann concluded that there is reasonable agreement between values obtained by the two techniques. It was found that, at megacycle frequencies, κ/μ is nearly zero for gases and liquefied gases, is 'small' (say 0.5) for bonded liquids, such as water and the alcohols, is larger (5–20) for most organic liquids and largest for a group of non-polar liquids including carbon tetrachloride, benzene and carbon disulphide. The last-named substance has the highest known value with $\kappa/\mu = 200$ at room temperatures.

These facts, however, merely provide a start, and a number of problems remain. From equations (1) and (2) it can be deduced that the sound absorption coefficient α is proportional to the square of the

frequency. This is not always found (for example, with carbon disulphide and acetic acid), and deviations are often explained in terms of a 'relaxation' theory. What then is the significance to be attached to p and μ' in equation (1), and how is the theory of acoustic streaming to be modified? Further, there is some doubt about certain aspects of the technique employed by Liebermann for measuring the streaming velocities; this is partly connected with questions of interpretation of results and partly with difficulties intrinsic in the technique.

Experimental questions concerning acoustic streaming were discussed by E. G. Richardson (Newcastle upon Tyne). He recalled that streaming was first recorded with sonic sources by Dvořák³ and afterwards investigated by Rayleigh⁴, Andrade⁵ and Schlichting⁶, who showed that at low frequencies the effect is due to vorticity generated in the boundary layer. Under these conditions recent experiments at Newcastle show that, if the temperature is varied, streaming appears to increase with decreasing viscosity. This also appears to remain true in the megacycle region, even for substances with large bulk viscosity. It was said that dissipative heating of the medium seems to be due to shear viscosity only, and that experiments on absorption of sound in capillaries can be explained in terms of the boundary effects, which are due only to shear viscosity. Richardson suggested that in view of the high vapour pressures of substances with large bulk viscosity, the possibility that cavitation plays a part in the streaming should be kept in mind. In connexion with this point, Prof. P. Biquard (Paris) remarked that, in order to investigate the effect of pressure and the possible effect of cavitation, he has experimented with various liquids at pressures up to about 100 atmospheres by measuring the scattering of light. The results show that absorption of energy under pressure can be accounted for quite simply by taking into account the percentage variation of viscosity with pressure. The question was also raised as to whether the absorption coefficient depends on the amplitude of the source and the hydrostatic pressure. The replies seemed to indicate that the reported measurements made with continuous waves, using pressure-vane techniques, do show a variation with amplitude, but those made with pulsed waves do not. Increase of pressure has been observed to diminish the absorption in carbon tetrachloride and toluene; but this may be ascribed, in part, to changes in the first coefficient of viscosity and the velocity of sound, both of which enter into the Stokes absorption formula.

S. M. Karim (Karachi) mentioned the work he has recently carried out on the Liebermann type of experiment. He pointed out that the values obtained for μ'/μ sometimes appear to depend on the intensity of the sound beam, probably on account of the development of turbulence. Further, the choice of the ratio of the diameter of the sound beam to that of the tube influences the experimental results. Additional detailed experimental work is required before firm conclusions can be drawn.

The difficulties of separating boundary layer effects from Eckart streaming were emphasized by P. E. Doak (Manchester), who went on to show how Eckart's original theory can be extended to deal with relaxing media while still neglecting boundary effects. He reached the conclusion that, apart from a term in the viscosity gradient, the streaming velocity is in all cases proportional to the coefficient

of sound-absorption. Further, it appears that the streaming is generated by interaction between the stationary and the radiative parts of the acoustic field. If either should disappear, or if the motion is one-dimensional, no streaming is possible. Although this work was based on the notion of vorticity sources, the conclusion concerning the role of sound absorption was also demonstrated by J. E. Piercy and J. Lamb (London). They considered the propagation of a sound beam along the axis of a tube. Due to attenuation, there will be a gradient of radiation pressure proportional to the absorption coefficient, and this can be taken as a body force acting on the fluid—which can now be regarded as incompressible. Starting from this point of view, the velocity profile can be found explicitly in mathematical form. Apparatus embodying this principle has been constructed; it aims at a direct measurement of the radiation pressure of the beam, together with a measurement of the pressure-head generated by a known length of beam. Preliminary measurements at 1 Mc./s. and 25° C. show excellent agreement with other techniques for relative values of $(\alpha/\rho) \times 10^{17}$ ranging from 24 (water) to 5,500 (carbon disulphide).

Both P. E. Doak and R. O. Davies (London) emphasized the fact (due to Mandelstam and Leontovich) that there is no way of distinguishing the effects of a bulk viscosity and a relaxation process associated with frequencies much higher than those of the experiment. The latter author formulated equations of hydrodynamics applicable in a relaxation region and developed the plane-wave solution in order to demonstrate the conclusion just noted. He showed that the presence of relaxation modifies the classical contributions to absorption due to thermal conductivity and shear viscosity. Apart from relaxation associated with intra-molecular vibrational motion (which seems to be present in all liquids with $\kappa/\mu > 20$) there are contributions to the absorption coefficient due to structural changes and shear relaxation which can be investigated experimentally only by working at frequencies comparable with the inverse Maxwell relaxation time.

This aspect of the problem was elaborated by J. Meixner (Aachen), who showed that a liquid can be considered as the limiting case of an elastic body with 'after-effects'. The after-effect theory, when applied to a generalized stress-strain relation containing temperature and entropy, yields an apparent viscosity matrix whose main components become the first and second viscosity coefficients when the substance is isotropic. It is only under certain restrictions that arbitrary after-effect behaviour can be represented as a thermodynamic relaxation theory. When these restrictions are satisfied, parameters referring to shear and volume changes can be separated.

Underlining the fact that stationary transport is to be considered as a limiting case of relaxation, H. O. Kneser (Stuttgart) discussed shear flow and volume flow in gases. In the former case momentum parallel to a wall moving in its own plane is transferred perpendicularly to it with no energy change. The relaxation time is therefore comparable with the collision time and has not yet been observed. When, on the other hand, the wall moves perpendicularly to itself, momentum transfer is coupled with energy transfer and the attainment of a stationary state may be delayed if the molecules have internal mechanisms for storing energy.

J. H. Andrade (Welwyn) and J. Lamb reported further details concerning the intra-molecular relaxation of carbon disulphide centred around 75 Mc./s. at 25° C. and 31 Mc./s. at -63° C. They gave a relaxation theory of absorption involving an arbitrary number of relaxation processes, and then separated effects due to relaxation times much larger and much smaller than the inverse frequency-range of interest. It was suggested that the total magnitude of the volume relaxation still remaining unexplained at 200 Mc./s. can be estimated by assuming that for $f \rightarrow \infty$, $C_v \rightarrow 5R/2$ and $C_p \rightarrow 3R/2$.

Adopting an approach different from that of both the thermodynamic and the molecular theories, Sir Geoffrey Taylor presented a simple mathematical model which exhibits characteristics of a bulk viscosity. He supposes that small gas bubbles are dispersed in an incompressible liquid of shear viscosity μ , thus making the medium as a whole slightly compressible. The contraction and expansion of the bubbles are resisted by the viscosity of the surrounding fluid, and it is found that the second coefficient of viscosity is $4\mu/3v$, where v is the (small) proportion of the total volume occupied by the bubbles.

J. G. Oldroyd (Swansea) said that the quantities p and μ' in the basic equations of Prof. Rosenhead's presentation can, in certain special circumstances, be given precise meanings; but this involves the assumption that the values of the quantities are their 'instantaneous' ones.

In summing up the discussion, Prof. E. N. da C. Andrade remarked that the last time he had heard of the second coefficient of viscosity was when he was a student. The late Prof. Karl Pearson had introduced it into his lectures—only to evict it as quickly as possible; it now appeared to be a topic worthy of serious consideration. He pointed out that the second coefficient (μ') has not been defined in a physical way. But the bulk coefficient (κ)—the quantity used by Sir Geoffrey Taylor in his contribution—is so defined. A method of measuring μ' directly is very desirable. The experiments which had been described fell into two classes—those concerned with absorption and those concerned with streaming. From these the ratio μ'/μ has been determined. It is clear, he said, that there are two types of streaming: the type investigated by Schlichting, Andrade and others, and the type which the Liebermann experiment was designed to investigate. There are a number of faults in Liebermann's apparatus, however, which seem to have been eliminated in the excellent experiments of Piercy and Lamb. Richardson had noted that, of the various liquids he used, the five which exhibit marked streaming also possess higher vapour pressures. It appears to be more significant, however, that four of these liquids are non-polar while the fifth possesses only a small dipole moment. As regards absorption of energy in experiments in capillary tubes, Richardson had mentioned that it seems to be chiefly explained by the first coefficient; but this is to be expected, since the skin-friction effect, which involves shearing motion, will predominate in the experiments, so that the second coefficient will not be able to play a large part. The discussion had clarified the two theoretical methods of approach (one based on a formal mathematical presentation and another based on the physical relaxation theory), and it may now be possible to present relaxation theories in terms of formal mathematics. It does not appear strange, he said, that we understand so

little about the second coefficient of viscosity when we realize how little we know about the first. We appear to be at the beginning of a very important study of the internal vibrations of molecules, leading, it is hoped, to a clarification of the fundamental concepts of fluid dynamics. Prof. Andrade stressed the importance of choosing the best fluids for experimental and theoretical work; water is most unsuitable, as it has a wide variety of abnormal characteristics.

A full report of the meeting will appear in the *Proceedings of the Royal Society* in due course.

R. O. DAVIES
L. ROSENHEAD

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³ Dvořák, V., *Pogg. Ann.*, **157**, 61 (1876).

⁴ Rayleigh, Lord, *Phil. Trans. Roy. Soc.*, **178**, 1 (1884).

⁵ Andrade, B. N. de O., *Proc. Roy. Soc. A*, **124**, 445 (1932).

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OBITUARIES

Dr. E. M. Elderton

ETHEL MARY ELDETON was born on December 31, 1878, and died on May 5, 1954. She entered Bedford College for Women in 1895 in the Faculty of Arts and went down in 1899 without having sat for a degree. University was followed by a period of teaching; but the real pattern of her life-work did not emerge until about 1905, when through Alice Lee she worked first for Leonard Darwin and then for Francis Galton, being made secretary of the Eugenics Record Office in 1906. From this modest beginning she became successively Galton Scholar, Galton Fellow, assistant professor and reader in eugenics in University College, London (1931). She retired in 1935.

During the whole of the period in which she was either attached to, or a member of, University College she was actively engaged in both teaching and research. At the College she was a member of a research team headed by Karl Pearson, and as such much of the work she did was contained in the co-operative effort; but evidence that she was capable of a sustained piece of individual research will be found in such a memoir as "Report on the English Birth Rate 1914", to quote only one of a number of publications with a eugenic flavour.

As a person she was delightful, as an expositor she was unrivalled for clarity of thought and lucidity of

expression, and as a teacher she had the rare gift of enthusiasm and the ability to impart it to others. There must be many to-day who owe to her their first steps in statistics and the knowledge and self-confidence that things were not so difficult as more mathematically minded teachers had made them appear. Her essential modesty hid an ability which caused the first Galton Fellow to write in 1906: "Miss Elderton has certainly been a remarkable success at the Eugenics Office; but I think her marvellous energy and quickness to learn anything new would have enabled her to succeed at anything she undertook".

Her work was recognized by the award of the Weldon Medal in 1919, and in December 1931 the University of London conferred on her the degree of D.Sc.

F. N. DAVID

Dr. W. T. Mathias

WILLIAM T. MATHIAS, lecturer in botany in the University of Liverpool, suffered a heart attack in his laboratory on May 19, and died in hospital an hour or so later. This was a severe blow and shock to his family and friends, for only the previous day he had taken the senior students on a field excursion to North Wales.

He was born in Cardigan, South Wales, in 1900, and graduated in agriculture from the University College, Aberystwyth, in 1922. He then specialized in botany. Although offered a scholarship for research at Oxford, he chose to go to Bangor as an assistant lecturer under Prof. D. Thoday; but a year later, in 1924, he moved to the Botany Department of the University of Liverpool. His early training under Prof. Lloyd Williams led to an interest in the problems associated with the life-cycles of marine algae, and Mathias's published researches on *Callithamnion* and *Phloeoispora* were in this field. For some years past he had been making a similar study of *Chordaria*.

Mathias was an enthusiastic and willing teacher, and always carried a large share of the teaching load of the Department. He took an active part in extramural work and in school examining, still finding time to help and encourage amateurs in their field collecting. He was for some years secretary of the University Military Education Committee, and took a very keen interest in the welfare and progress of the units associated with the University.

He is survived by a widow and two children; in 1931 he had married Miss Jane Evans, who was one of his former students at Bangor.

ALAN BURGESS

NEWS and VIEWS

The Kalunga Prize: Mr. Waldemar Kaempffert

THIS year the Kalunga Prize, which is awarded annually by a panel of judges appointed by Unesco, has gone to Waldemar Kaempffert, who has been science editor of the *New York Times* since 1927 except for the short spell which he spent as director of Chicago's Museum of Science and Industry. Born in New York City in 1877, he is universally regarded as the dean of American science writers. His long and distinguished career has included the editorship of *Scientific American* and *Popular Science Monthly*.

He has written a number of books; but by far the most important part of his life's work has been his writing for the *New York Times*, his regular articles in the *Sunday New York Times Magazine* being particularly popular among laymen and scientists alike. "Current Biography" has justly summed up his career in these words: "No one has done more to bridge the gap between the abstract hypotheses of the laboratory and the mind of the common man". The award will be accepted everywhere as an excellent choice and as a tribute to the great importance of the profession of science writing nowadays. It reflects

the change in the conditions of award whereby the Kalunga Prize now becomes a mark of recognition for "a distinguished career of public service in the interpretation of science". It is interesting that the nomination which brought Mr. Kaempfert's name before this year's judges came from the Association of *British Science Writers*, which exists to improve the standards of science writing in Great Britain. Mr. Kaempfert's views on the present state of the press relations of science were vigorously expressed in a recent number of the *Bulletin of the Atomic Scientists* (November 1953) in an article headed "Neither is Perfect".

Department of Genetics of the University of Sheffield

THE recent establishment of a separate Department of Genetics in the University of Sheffield is the logical development of the stimulus given to this subject in the Departments of Botany and Zoology when Dr. J. M. Thoday was appointed as lecturer in cytogenetics in 1947. In addition to the immediate impact of the teaching of genetics on the two parent Departments, the subject has an increasing importance in shedding new light on biological problems at all levels. This has been emphasized by courses given in medical and microbiological departments and by the steady growth of a thriving research school. The independence accorded to genetics in Sheffield now makes possible extensions into wider fields without interfering with the teaching of genetics as hitherto to students of botany and zoology. While Dr. Thoday's research interests are varied, they have perhaps expressed themselves most prominently in investigating the effects of ionizing radiations on chromosome structural changes and the further influence of environmental factors on the frequency of these changes. In setting up the new Department, the University has recognized the rightful independence of a subject which cuts across the formal frontiers of long-standing subjects like anatomy, botany, physiology and zoology. That it has been thought fit to appoint Dr. Thoday as senior lecturer in charge is a testimony to his ingenuity as a research worker, his inspiration as a teacher and his insight as a supervisor of research.

Centenary of Boole's "The Laws of Thought"

THE centenary of the publication of the "Laws of Thought" by George Boole was celebrated at the Royal Irish Academy, Dublin, during May 24-25. The "Laws of Thought" was published in 1854 while Boole was professor of mathematics in Queen's College, Cork; but his association with the Royal Irish Academy had begun ten years earlier when his friendship with the Rev. Charles Graves led him to use the *Proceedings and Transactions* of the Academy as a medium for the publication of some of his papers. At the recent meeting in Dublin the guests included Prof. L. E. J. Brouwer (Blaricum, Holland), T. L. Craven (Automatic Telephone Co., Liverpool), W. C. Kneale (Exeter College, Oxford), Rush Rhees (University College, Swansea), Prof. J. B. Rosser (Cornell University), Sir Geoffrey Taylor, and the Rev. Ivo Thomas (Hawkesyard Priory, Staffs). The afternoon of May 24 was devoted to a formal celebration, when Sir Geoffrey Taylor, a grandson of Boole, spoke on George Boole and his family connections, and the Rev. Canon Feys gave an address entitled "Boole's Achievement in Developing Symbolic Logic". On the morning of each day there was

a technical session at which the following papers were read: F. E. Hackett, the Method of George Boole; J. B. Rosser, Boole and the Concept of Function; T. L. Craven, Boolean Algebra and Switching Current Design; Rev. Ivo Thomas, Boole's Concept of Science; Rev. Canon Feys, Boole's Technique in the "Laws of Thought"; Michael MacConaill, the Likeness of Correlated Relations; and L. E. J. Brouwer, the Effect of Intuitionism on the Classical Algebra of Logic. These papers will be published in a special issue of the *Proceedings* of the Academy.

Artificial Stimulation of Rain

IN the House of Commons on June 15, Mr. Geoffrey de Freitas asked the Under-Secretary for Air whether the physical sub-committee of the Meteorological Research Committee had yet considered the problem of weather modification; and what conclusions it reached. This matter had been raised earlier by Mr. de Freitas (see *Nature*, March 13, p. 474). Mr. George Ward, in a written reply, stated that the committee had recently considered this subject and come to the conclusion that there is no reliable evidence that rainfall has ever been artificially increased on an economically useful scale, and that there is no scientific basis for believing that any method yet proposed would be successful in achieving such a result. Since there is so much at stake, however, the committee considers that scientifically conducted research should be intensified, particularly into the large-scale diffusion of airborne particles, the analyses of natural nuclei concentrations and the design of the large-scale field trials which would be necessary to test the effectiveness of the proposed methods of operation. The Meteorological Office is putting in hand the studies recommended by the sub-committee.

Research and the Future of the World

IN an address entitled "Today's Research and Tomorrow's World" to guests of the board of directors of the Stanford Research Institute at Los Angeles on January 20 (pp. 16. Washington, D.C.: Carnegie Institution of Washington, 1954), Dr. Vannevar Bush, reviewing the possibilities of atomic warfare which confront us, said that whatever the future has in store, whether an atomic war, a long stalemate or a gradual transition to a more salutary position, for the present we should, by creating strength in the free world, seek to maintain peace and postpone a fully developed impasse. One phase of this, he said, involves building an adequate defence system for the North American Continent, which at present is nearly wide open to aerial attack. This lack of balance is due chiefly to two reasons: first, it has only fairly recently, through technical advances, been possible to ensure a reasonable and economic degree of protection, sufficient to raise doubt in the mind of an enemy as to the success of a single surprise attack; secondly, the national military planning organization is short of the sound integrated system essential for national safety. In Dr. Bush's opinion, the United States could have a defensive system which is worth while, without unduly burdening its economy or unwise sacrifice of any other element in its military preparedness, and should insist on having it and the improved military planning. After referring also to the need to make its system of democracy work and maintain vigorously some of its ideals of freedom, Dr. Bush turned to some of the trends in research and development which offer new hope. The bloc-

soming of the biological sciences and their application in agriculture, the opening-up of arid areas by solar power, new methods of sterilizing and packaging, etc., offer prospects of a breathing space from the pressure of increase in population. Chemical control of mental disease might be a powerful weapon in the war against man's ills. Progress is also being made in the handling of giant molecules, which require a new type of chemical thinking. There have been great strides in the development of machines for supplementing and substituting human thought; but this process needs to go much further before we can cope with the complexities of the coming world. Dr. Bush referred specifically to problems of communication in which new techniques of electronic selection, photomicrography and facsimile transmission would replace the conventional library. There is, however, a reason for the search for knowledge which is inherent in the nature of man. His search for understanding is prompted not simply by his immediate needs for food and shelter, but also by his inherent urge to know. Science should be pursued, Dr. Bush concluded, in response to the urge which lies deep in all of us to press on towards greater understanding.

The National Research Development Corporation

In the debates on the Development of Inventions Bill and again in the recent report on industry and science issued by the Manchester Joint Research Council, opinion was expressed that the work of the National Research Development Corporation is not sufficiently well known in industry. The *NRDC Bulletin*, of which the first number appeared in April (No. 1; pp. 20; 1954), is an attempt to remedy this position by informing industry of the inventions which can be made available by the Corporation in addition to, or in place of, the existing routine circulation procedure. It is hoped that in time the *Bulletin*, which will be published quarterly, will become the Corporation's chief vehicle for informing industry of such inventions. Each issue will include short notes of the inventions recently available, as well as on other inventions which have been the Corporation's property for some time and which it is considered should receive wider publicity. It is also proposed that each issue shall contain at least one article about other aspects of the Corporation's activities. Besides the descriptions of selected inventions, the present issue includes a note on the granting of licences and a list of the Corporation's patent holdings, arranged in the eight groups: electronics; electrical engineering; mechanical engineering; civil engineering; aero and auto engineering; scientific instruments; chemistry and plastics; miscellaneous and domestic. The *Bulletin* is obtainable from the Exploitation Officer, NRDC, 1 Tilney Street, London, W.1.

Simultaneous Translation at a Scientific Meeting

On May 11, at a meeting held at the Institut Pasteur in Paris, Prof. J. H. Quastel, professor of biochemistry in McGill University, Montreal, delivered by invitation an address on "Soil Metabolism". The occasion was noteworthy for the use of a system of simultaneous translation, analogous to that used at meetings of the United Nations and similar bodies. Thus Prof. Quastel delivered his lecture in English, and the difficult task of simultaneous translation was carried out by Dr. P. R. Lépine, of the Institut Pasteur. Dr. Lépine had actually seen Prof. Quastel's

manuscript for a short time before the meeting; it was nevertheless a considerable achievement to be able to give a simultaneous translation of a scientific discourse in a way which the audience found to be completely successful. At the conclusion of the lecture, Prof. J. Trefouël, director of the Institut Pasteur, thanked Prof. Quastel and, as is customary when distinguished visitors address the Institut Pasteur, presented to him a silver medal, which bears a figure of Pasteur by the sculptor Roty.

Recognition of Intoxication

In a study of the chemical diagnosis of alcoholic intoxication (*S. Afr. J. Med. Sci.*, 18, 141; 1953), J. J. Prag has attempted to correlate the usual clinical criteria of drunkenness with blood-alcohol levels. The tests were made on a hundred motor-car drivers, charged with driving under the influence of alcohol, and on a group of volunteers. One of his conclusions is that with blood-alcohol levels below 0.05 per cent (gm./per 100 ml.) nobody is intoxicated in the medico-legal sense, while with a level above 0.15 per cent most people (more than 90 per cent) are definitely intoxicated. The weakness of the chemical diagnosis lies in the blood-alcohol range between 0.05 and 0.15 per cent, where individual variations in symptoms are very great. The average ratio of blood-level to urine-level of alcohol was found to be 1:1.31, though the blood-level reflects more directly the alcohol concentration affecting the nervous system. With a given amount of alcohol, the greatest degree of intoxication is reached well before the blood-level reaches its maximum. If sugar is taken with alcohol, the symptoms are more severe but pass off more quickly, apparently owing to more rapid absorption and removal of alcohol. The results of this work are, on the whole, in harmony with the recent report entitled "The Recognition of Intoxication" by the Committee of the British Medical Association (1954) under the chairmanship of Prof. E. J. Wayne. Both Prag and the Committee stress that symptoms of impaired judgment may appear after drinking small amounts of alcohol and long before the stage of definite intoxication is reached. Diagnosis of drunkenness should not depend solely on results of laboratory tests, but on clinical findings, combined, if possible, with laboratory tests.

Tobacco Curing Studies

BIOCHEMICAL and physical changes which take place in tobacco leaves during fine-curing are described in some detail by H. O. Askew *et al.* (*N.Z. J. Sci. and Tech.*, B, 35, 4, 344; 1954). Data for changes in weight and moisture content of tobacco leaves during fine-curing show that the rate of loss of water is governed by the temperature and humidity conditions in the kiln. In the early stages of curing, 93-95 per cent of the loss of weight of the leaf is due to loss of water. During the colouring and fixing stages, rapid hydrolysis of starch to sugars, mainly glucose and fructose, and hydrolysis of protein-nitrogen to simpler compounds, take place. For the first 50 hr. of curing, the average rates of hydrolysis were: starch 0.35 per cent in two experiments; and protein-nitrogen 0.5 per cent and 0.7 per cent, respectively. Increase in reducing-sugars content was proportional to the amounts of protein and of starch hydrolysed. Loss of dry-matter can be nearly completely accounted for by requirements of water, by the products of hydrolysis, and by difference between over-all loss of starch and that required for

formation of soluble sugars. Internal transformations involving no losses of dry-matter may also have occurred. Variation in the contents of total non-volatile ether-soluble acids and malic acid was appreciable, but for oxalic and citric acids it was relatively small. Nicotine content did not vary during curing. No certain losses of total nitrogen were found. The pH value of the leaf did not vary. Neither soluble phosphate, soluble sulphur and protein-sulphur contents, nor soluble calcium content, varied during curing of the leaf.

Curing of Sheepskins In the Sudan

A LARGE-SCALE experiment on the curing of sheepskins has been carried out in the Sudan. The straight drying of sheepskins was compared with dry salting in the hot and in the cold seasons; drying in the sun was compared with shade-drying, and rope-drying with framing. At each season nine batches of fifty skins each were treated, the skins later being dressed in England as white suede. Straight drying gave almost consistently the best leather and cold season 'cure' was better than hot. Damage was found to be present in the raw skins although it could only be recognized microscopically. In its milder form it caused the grain to be rubbed off during processing or caused holes to appear in the skins; extreme damage led to complete disintegration and the skins dropped to pieces. It is suggested that an immediate improvement in the quality of 'curing' in the Sudan might be achieved by abandoning dry-salting, and by straight-drying the skins without delay, avoiding excessive heat in the direct sun (*Colonial Plant and Animal Products*, 3, No. 4: 1952-53).

Formation of Asparagine In Lupin Seedlings

THE formation of asparagine in etiolated seedlings of *Lupinus albus* has been considered in some detail on the basis of analytical and experimental investigations by A. N. Meiss (*Bull. Connecticut Agric. Exp. Sta.*, No. 553, 1; 1952). In this bulletin recent work on the biochemistry of asparagine formation is reviewed, while in the experimental section the germination and growth of etiolated seedlings are described and comprehensive analyses of these materials submitted, reference being made to the nitrogen fractions, lipids, soluble and insoluble carbohydrates, organic acids, moisture and ash. In the discussion of the experimental data, the relation of asparagine accumulation and growth, the sources of the asparagine nitrogen and carbohydrate, and the role of the organic acids and mineral nutrients are considered. The principal conclusion which is drawn is that the large accumulation of asparagine in etiolated seedlings of *Lupinus* is a consequence of a normal, but obligatory, utilization of seed protein as a respiratory substrate. The asparagine which arises by secondary synthesis—in the *Lupinus* seedlings it is about 90 per cent of the total formed—is considered to be a product of protein respiration, and as such is not metabolized further until acute starvation conditions prevail. Other observations and results which are associated with this conclusion are set out and discussed in detail.

Growth of Excised Roots

In one of a series of studies of the growth of excised roots in controlled aseptic culture, J. C. Skinner and H. E. Street have investigated the cultural requirements of a number of strains of

Sensio vulgaris (groundsel), which also have been, and are being, studied genetically (*New Phyt.*, 53, 1, 44; 1954). Earlier work, in which it was found that excised roots of strains within a species may show clearly defined differences in their capacity for 'essential metabolite' synthesis, is reviewed. The underlying point of view in these new physiological-genetical studies is that more detailed examination of the differences in the growth requirements of different strains should enable a comparative physiology of excised root systems to be constructed. The differences observed in the growth responses of cultured excised roots of tomato strains to added B vitamins suggests that this technique may be used to advantage in the study of the genetical control of synthetic processes in flowering plants. Seeds of a number of geographical strains of *Sensio vulgaris* were available and excised roots have now been successfully cultured. The present paper gives details of a technique for the establishment and maintenance of excised root clones and describes the growth responses of one clone to a range of nutritive treatments. Subsequent work has involved comparison of the growth in selected culture media of the roots of a number of geographical strains and of hybrids between them, and study of the segregation of excised root characters in the *F*₂ generations of these crosses.

Flake-Tool Cultures In South Africa

AN article by Prof. T. F. Dreyer, entitled "The Origin and Chronology of the Fauresmith Culture" (*Res. Nat. Museum, Bloemfontein*, 1, Part 3; 1953), makes an interesting suggestion as to the origin of the flake-tool cultures which appear with some suddenness at the end of Fauresmith times. The current view of many prehistorians in South Africa is that the Middle Stone Age complex (flake-tool industries) is directly derived from the Stellenbosch (core-tool industries), the Fauresmith being the latest of the Stellenbosch series. It is not easy to explain why this change should have taken place at the time it did and why the coupe de poing which had persisted for perhaps scores of thousands of years throughout many changes of climate and conditions should have so rapidly disappeared and been replaced by others so completely different, unless influences from outside had operated. In Europe and northern Asia, where a similar phenomenon occurs, it can be shown from distribution maps that the flake-tool making cultures existed farther to the east contemporarily with the core-tool making people, and replaced them in western Europe towards the end of Würm I times. Prof. Dreyer suggests a somewhat similar solution for the problem in South Africa in that he believes the Florisbad (flake-tool) culture to be older in time than has been hitherto allowed, and that it was the influence of this culture on the Fauresmith that led to the development of the Middle Stone Age; and that it was fertilization by the Florisbad culture that gave rise to the profound changes which took place towards the end of the Fauresmith period. Certainly the natures of the two cultures were entirely different. The coupe de poing folk were conservative and uniform in their implement evolution—the development of the industries throughout millennia is the same whether in South Africa, East Africa or Western Europe (= the Chellean-Acheulean culture). The flake-tool makers were quite different, always experimenting and producing changes and new types of tools. It is difficult to see how the one

culture could have evolved into the other without some such explanation as Prof. Dreyer proposes. But the ultimate origin of the flake-tool folk, whether one is considering those in northern latitudes or their cousins in South Africa, still remains a mystery.

Syntheses of a Pituitary Hormone

THE synthesis of oxytocin, a principal hormone of the posterior pituitary, has been announced by Prof. V. du Vigneaud, professor of biochemistry, Cornell University Medical College, and his colleagues, C. Reeser, J. M. Swan, C. W. Roberts, P. G. Katsouyannis and S. Gordon (*J. Amer. Chem. Soc.*, 75, 4879; 1953). Oxytocin causes contractions of the uterus, and is also concerned with the 'let-down' of milk from the mammary gland. Previous work had shown that natural oxytocin on hydrolysis yields leucine, isoleucine, tyrosine, proline, glutamic acid, aspartic acid, glycine and cystine, and three molecules of ammonia. Based on these results, a synthetic product was obtained by a method described and had the biological properties of natural oxytocin. The authors remark that, if the identity of the synthetic material with oxytocin is confirmed, this will be the first synthesis of a polypeptide hormone.

Japanese Journal of Tuberculosis

MUCH activity is evident in Japan in the field of tuberculosis, and in no less than six universities there are institutes devoted to research in this disease, or in which such study figures prominently. These institutes have now joined in sponsoring a quarterly journal, the *Japanese Journal of Tuberculosis* (pp. 98; November 1953; from the Institute of Infectious Diseases, Shiba-Shirokane-Daimachi, Minato-Ku, Tokyo), under the editorship of Y. Takeda and with a representative editorial board. The first number presents mainly laboratory studies, but also some articles on clinical and epidemiological aspects. It is well produced and is in English. This lusty newcomer to national specialist literature invites comparison with the several British tuberculosis journals, which are showing little success in attracting scientific contributions—particularly those of a laboratory nature—away from their very scattered distribution in other publications.

Photoelectric Scanners for use In Paper Electrophoresis

THERE are numerous descriptions in the literature of instruments for measuring the intensity of the dyed serum protein bands after electrophoresis on paper, which utilize a photoelectric cell for measuring the light transmitted or reflected from a suitable source. By plotting extinctions at given distances along the paper strips, a graph is obtained which provides a quantitative evaluation of the proteins present. Such instruments are now produced commercially. The firm of Evans Electroscelenium, Ltd. (Harlow, Essex), provides, in addition to the scanning apparatus, a power unit and specially designed bath for carrying out the initial protein separation. As the scanning apparatus employs transmitted light, the dyed paper strip requires to be wetted with a suitable liquid to render it translucent. A frame carries the translucent strip between two glass plates and has a platform for holding a sheet of graph paper. The whole is moved across the light source, and extinctions read off from a microammeter and plotted on the graph paper. Joyce, Loeb and Co.,

Ltd. (Vine Lane, Newcastle upon Tyne 1), produces a somewhat more elaborate scanning apparatus (Model 2SR), which incorporates a double-beam amplifier principle and measures reflected light, obviating the need for rendering the paper translucent. It also has a framework for moving the paper across the light source and a platform for holding graph paper; but instead of reading off the extinctions, their values are directly plotted on the graph paper by a pen attached to a slider which is adjusted until the milliammeter reads zero. A feature of both instruments is that readings may be carried out quickly and easily. They are thus suitable for routine clinical investigations. The instruments are also adaptable for measuring the intensity of coloured spots on paper chromatograms.

Determination of the Resolving Power of Photographic Lenses

CIRCULAR 533 of the National Bureau of Standards, Washington, D.C., entitled "Method for Determining the Resolving Power of Photographic Lenses" (pp. iv + 27 + 2 charts. Washington, D.C.: Government Printing Office, 1953; 1 dollar), replaces Circular 428 (1941), and provides the photographer with two sets of improved charts by which the resolving power of a photographic lens may be numerically measured with respect to a definite scale of values. It gives a detailed description of the procedure and technique to be followed in order that comparable values may be obtained by different observers in widely separated laboratories. The average amateur photographer can use the simple objective method described with equipment normally available. One set of charts consists of six high-contrast charts, printed in black ink on a white background, and the other set contains six low-contrast charts, printed in grey ink on a grey background. The range of the charts is 12–80 lines/mm. in contrast with 3.5–56 lines/mm. of the charts in Circular 428. Additional applications to the testing of goggle lenses for definition and prismatic power and of telescopes and binoculars for definition are also discussed in Circular 533.

Hydraulic Research in the United States

INFORMATION compiled from various hydraulic and hydrologic laboratories, and from reports of research projects in private, State or Federal institutions in the United States and in five institutions in Canada, is contained in Miscellaneous Publication 208 of the National Bureau of Standards, entitled "Hydraulic Research in the United States" (pp. xii + 204; edited by Helen K. Middleton and Sonya W. Matchett. Washington, D.C.: Government Printing Office, 1953; 1.25 dollars). The projects are numbered chronologically, and the number once assigned is repeated for identification purposes until the project is completed. Numbers above 1544 refer to projects reported for the first time; lower numbers to projects reported earlier in the previous editions (Misc. Publication 201, 1951; Misc. Publication 205, 1952). The information listed gives the title of the project; for whom conducted; the name of the person to whom correspondence should be addressed; the nature of the project (whether experimental, theoretical, etc.); and a brief description of the work, the results so far obtained and any published reports. There is also a comprehensive subject index. In the brief foreword by Dr. A. V. Astin, director of the National Bureau of Standards, Washington,

D.C., it is mentioned that a similar bulletin, "Hydraulic Research", compiled and published by the International Association for Hydraulic Research, contains information on hydraulic research conducted outside the United States, and a companion bulletin, "Directory of Hydromechanics Research Projects in the United States Related to Naval Architecture and Marine Engineering", is prepared by the Hydromechanics Committee of the Society of Naval Architects and Marine Engineers.

Physicists In Britain during July

A list of those taking part in the Eighth General Assembly of the International Union of Pure and Applied Physics, to be held in the rooms of the Royal Society (Burlington House, London, W.1) during July 7-10, has been prepared and is obtainable on application to the assistant secretary of the Royal Society. The numbers of active participants from various countries are as follows: Great Britain, 14; United States, 9; Germany, 7; Canada, 6; France and Italy, 5 each; Spain and Japan, 3 each; Australia, Denmark, Netherlands and Switzerland, 2 each; Belgium, India, Israel and Sweden, 1 each. Since such a comparatively large number of leading foreign physicists will be in Great Britain for the Assembly, a number of other meetings have been arranged around about the same time (see *Nature*, January 30, p. 194), and it is expected that many of the foreign physicists will be attending one or other of these meetings.

Meeting of Nobel Prize-winners in Lindau

As in former years, a meeting of Nobel prize-winners will be held in Lindau, Lake Constance, during June 28-July 2. This year the speakers will discuss various aspects of medicine, which is the second time that this subject will be considered at one of these meetings, the first occasion being at the original meeting in 1951. Ten addresses will be given as follows: Prof. Gerhard Domagk (Wuppertal), Chemotherapie der Tumoren; Prof. Hans von Euler-Chelpin (Stockholm), Faktoren der Blutbildung; Prof. George de Hevesy (Stockholm), Eisenstoffwechsel; Prof. Corn. Heymans (Ghent), über Selbststeuerung des arteriellen Druckes und Hypertension; Dr. Paul Hermann Müller (Basle), Antibiotica, besonders ihre Anwendung im Pflanzenschutz; Prof. T. Reichstein (Basle), die wichtigsten Hormone der Nebennierenrinde; Prof. Frederick Soddy (Oxford), the Wider Aspects of the Discovery of Atomic Disintegration; Prof. George H. Whipple (Rochester, N.Y.), the Dynamic Equilibrium of Body Proteins, Hemoglobin, Plasma Proteins, Organ and Tissue Proteins; and Prof. Adolf Butenandt (Tübingen) and Prof. Otto Warburg (Berlin), whose topics are not yet decided. Also participating will be Prof. Otto Hahn (Göttingen) and Prof. Albert Schweitzer (Lambaréné-Gabon). The addresses will be of general interest to both medical practitioners and research workers, and opportunities will be provided for discussion. A comprehensive programme of excursions has also been arranged. Further information can be obtained from the Sekretariat der Tagungen für Nobelpreisträger, Lindau-Bodensee, Postfach 11.

Royal Commission for the Exhibition of 1851: Awards for 1954

THE Royal Commission for the Exhibition of 1851 has awarded senior studentships for 1954 (value £600

a year for two years) to the following for research as indicated: Miss A. I. Bailey (Witwatersrand), physics at the University of Cambridge; Dr. G. A. Horridge (Cambridge), invertebrate physiology at the University of Cambridge; R. Hicks (Wales), civil engineering at University College, Cardiff; and A. D. Walker (Bristol), vertebrate palaeontology at King's College, Newcastle upon Tyne (University of Durham). The Commission has also awarded the following overseas scholarships for 1954 (value £450-£500 for two years). *Canada*: M. J. Fraser (Dalhousie), colloid chemistry at the University of Cambridge; M. Onyszchuk (McGill and Western Ontario), inorganic chemistry at the University of Cambridge; and J. A. Kuehner (Bishops and Queen's University, Kingston), nuclear physics at the University of Liverpool. *Australia*: P. J. Stephenson (Queensland), geology at the Imperial College of Science and Technology, London; and F. W. Eastwood (Sydney), organic chemistry at the University of Oxford. *New Zealand*: G. N. Maloolm (New Zealand), physical chemistry at the University of Manchester. *South Africa*: Dr. S. Papert (Witwatersrand), mathematics at the University of Cambridge. *Republic of Ireland*: Dr. M. F. Maguire (Ireland and Aberdeen), biochemistry at the University of Cambridge. *Republic of India*: K. Aghoramurthy (Madras and Delhi), organic chemistry at the University of Oxford; and S. Chandra-sekhar (Nagpur), physics at the University of Cambridge.

National Research Council of Canada Fellowships for Medical Research

EACH year the National Research Council of Canada has awarded the following medical fellowships, totalling 76,900 dollars plus travelling allowances, for research at the institutions indicated. *Senior Medical Research Fellowships*: Dr. W. G. B. Casselman, Banting and Best Department of Medical Research, University of Toronto; Dr. C. N. Crowson, Department of Pathology, Queen's University, Kingston, Ontario; Dr. P. C. Fitz-James, Department of Bacteriology and Immunology, University of Western Ontario; Dr. R. W. Gunton, Department of Medicine, University of Toronto, and at the Toronto General Hospital; Dr. F. C. Heagy, biochemistry and bacteriology at the University of Western Ontario; Dr. H. Kalant, pathological chemistry at the University of Toronto; Dr. J. T. Nichol, biophysics at the University of Western Ontario; Dr. J. W. Pearce, physiology at the University of Western Ontario; *Graduate Medical Research Fellow*: Dr. D. E. Bergsagel, blood coagulation at the University of Oxford; Dr. R. W. Cornett, cardiovascular physiology at Queen's University, Kingston, Ontario; Dr. T. E. Cuddy, cardiovascular physiology at the University of Manitoba; Dr. A. Davignon, physiology and biochemistry at Hotel Dieu Hospital, Montreal; Dr. Florence M. Hill, pathology at the University of Toronto; Dr. N. Kalant, endocrinology at the New England Centre Hospital, Boston, Massachusetts; Dr. S. J. Klebanoff, pathological chemistry at the University of Toronto; Dr. Dorothy Ley, iron metabolism in neoplastic disease at Toronto Western Hospital; Dr. A. Malkin, biochemistry at McGill University; Dr. J. C. Nixon, biochemistry at the University of Toronto; Dr. J. E. Nixon, physiological and pharmacological problems related to anaesthesiology at the University of British Columbia; Dr. P. Pollock, cardiology at Mt. Sinai Hospital,

New York City; Dr. Ingeborg C. Radde, endocrinology at the University of Toronto; Dr. R. F. Scott, pathology at the London Postgraduate Medical School, Hammersmith Hospital, London, England; Dr. Joan M. Vale, endocrinology at the University of Toronto.

University of Glasgow

AMONG those on whom the honorary degree LL.D. was conferred on Commemoration Day at the University of Glasgow, there were two members of the 1914 Shackleton Polar Expedition: Prof. Alexander Stevens, sometime professor of geography in the University of Glasgow, and J. M. Wordie, master of St. John's College, Cambridge, and director of the Scott Polar Research Institute. Other men of science were: Prof. Boris Ephrussi, professor of genetics in the University of Paris, whose ideas and early experiments have strongly influenced the present developments in biochemical genetics; and Sir Edward Salisbury, director of the Royal Botanic Gardens, Kew. Sir Arthur Trueman, sometime professor of geology in the University of Glasgow, and lately chairman of the University Grants Committee, was given the degree *in absentia*.

University of Birmingham

THE title of reader in analytical chemistry in the University of Birmingham has been conferred on Dr. R. Belcher, senior lecturer in analytical chemistry, and the title of university research fellow on the following: Prof. D. L. Anderson, associate professor of physics at Oberlin College, Ohio, who will be working in the Department of Physics for a year; and W. D. Seymour, during the tenure of his present appointment in the Department of Engineering Production. The following appointments have been made in the University: Dr. J. D. Eshelby, lecturer in physical metallurgy; Dr. A. B. Foster, Imperial Chemical Industries, Ltd., Fellow in the Department of Chemistry; and F. Edmondson, Leverhulme Fellow in the Department of Engineering Production.

University of Leeds

THE following appointments have been made in the University of Leeds: J. B. Butler, senior agricultural economist in the Department of Agriculture; Prof. B. E. Douglas and Prof. H. Taube (Chicago), Brotherton research lecturers in physical chemistry; E. W. Bennett, lecturer in the Department of Civil Engineering. The Department of Bacteriology has received a gift of £700 from Newton Chambers and Co., Ltd., for research.

The Night Sky in July

FULL moon occurs on July 16d. 00h. 29m., U.T., and new moon on July 29d. 22h. 20m. The following conjunctions with the moon take place: July 3d. 15h., Venus 5° N.; July 9d. 18h., Saturn 8° N.; July 14d. 00h., Mars 8° S.; July 28d. 08h., Mercury 2° S., and at the same time Jupiter 0° S. In addition to these conjunctions with the moon, Venus is in conjunction with Regulus on July 12d. 08h., Venus 1.1° N., and Mercury is in conjunction with Jupiter on July 28d. 00h., Mercury 1.9° S. Mercury, in inferior conjunction on July 6, is too close to the sun to be seen until near the end of the month; on July 31 it rises at 2h. 50m., nearly an hour before sunrise. Venus is an evening star, its times of setting being 22h. 20m., 22h. 50m. and 21h. 15m. at the beginning, middle and end of the month, respec-

tively. Its stellar magnitude varies between -3.5 and -3.6, and the visible portion of its illuminated disk between 0.76 and 0.66. Mars is visible throughout the night, setting in the early morning hours at 2h. 40m., 1h. 20m. and 0h. 15m. on July 1, 15 and 31, respectively. Its fairly close approach to the moon on July 14 has been already noticed, but observation of the planet will not be then very easy as the moon is only two days from full. During the early portion of July Jupiter is too close to the sun to be seen, but on July 15 it rises at 3h. and on July 31 at 2h. 25m. and is visible for a short time in the constellation Gemini. Saturn sets at 0h. 40m., 23h. 40m. and 22h. 40m. on July 1, 15 and 31, respectively, and is visible during the early morning hours in the constellation Virgo. Only one occultation of stars brighter than magnitude 6 takes place in July: 18 Aquar. reappears on July 17d. 22h. 45.8m., the observation being made at Greenwich. The earth reaches aphelion on July 3.

A partial eclipse of the moon takes place during July 15-16 and is visible at Greenwich. The circumstances of the eclipse are as follows:

Moon enters penumbra	July 15d. 21h. 47.7m.
Moon enters umbra	15 23 00.4
Middle of the eclipse	16 00 20.3
Moon leaves umbra	16 01 31.3
Moon leaves penumbra	16 02 52.9

Magnitude of eclipse is 0.411, the diameter of the moon being 1.

Announcements

THE 1954 award of the Commemorative Medal of Prince Albert I of Monaco (Prix Manley-Bendall) has been made to Captain de Corvette G. Houot and Engineer Officer P. Willm, of the French Navy, for their great achievement in descending to a depth of just over 2½ miles off Dakar in the naval bathyscaphe *F.N.R.S.-3*. The award was announced at the meeting of the Executive Committee of the Institut Océanographique held in June at Paris, and the donor of the Medal is generously having it struck in duplicate so that each recipient can possess it.

A Folk Gallery in the Abbey House Museum, Kirkstall, will be opened by Dr. F. Sherwood Taylor, director of the Science Museum, London, on July 2, at 11 a.m. The gallery is in the form of a small street called "Abbey Fold".

THE British Institution of Radio Engineers will hold its annual convention at Christ Church, Oxford, during July 8-12; the theme this year will be the application of electronics to industry. Representatives from many branches of industry as well as from the Armed Services, universities and technical colleges will be present. Further information can be obtained from the Institution at 9 Bedford Square, London, W.C.1.

A SYMPOSIUM on "The Comparative Endocrinology of Vertebrates" will be held in the Department of Zoology, University of Liverpool, during July 12-16. The symposium will be in two parts—the comparative physiology of reproduction, and the hormonal control of water and salt-electrolyte metabolism in vertebrates—under the respective chairmanship of Prof. S. Zuckerman and Dr. S. J. Folley. The proceedings of the symposium will be published as a memoir of the Society for Endocrinology. Accommodation is available at the University. All communications should be directed to the organizer, Dr. I. Chester Jones, Department of Zoology, University of Liverpool.

WORLD POPULATION AND RESOURCES

DURING May 5-6 the Executive of the International Geographical Union met in London, and the opportunity was taken to ask three of the vice-presidents to take part in a symposium on world population, under the chairmanship of the Union's president, Prof. L. Dudley Stamp, at the Society for Visiting Scientists.

The discussion was opened by Prof. George B. Cressey (Syracuse University, New York), the immediate past-president of the Union, who outlined briefly the world position which he had elaborated in his presidential address at the Washington conference of 1952¹. He used the now generally accepted figures of 2,500 million for the present world population, with a net increase of not less than 25 million per annum. The reality of the situation was vividly brought home by the comment that, by the end of the two hours of discussion, there would be another six thousand mouths to be fed and also another six thousand pairs of hands potentially available for work. Prof. Cressey said that he has been impressed by the extensive abandonment of soil-eroded land over such diverse regions as the United States and China where he has worked and at the same time by the poverty of tropical soils, and he takes the view that the expansion of lands under cultivation will do little more than balance the loss due to erosion. He looks, therefore, for expansion of food output from improved yields of lands already under cultivation. Turning to the position in the United States, where farming efficiency is commonly equated with output per man-hour and not with output per unit area, there is little doubt that agricultural output could be doubled merely by the full application of known techniques. In fact, the doubling of the production between 1900 and 1950 has been achieved by technological advances without any increase in man-power: the spectacular changes in yield which have resulted from the introduction of hybrid maize are indications of possibilities with other crops. The main problem for the future would seem to be an embarrassing surplus, and little likelihood that the prairie monoculturalist will be asked to give up his winter holiday in California in order to secure the greater output from the adoption of mixed farming.

Prof. George Kuriyan (Madras) gave a brief but vivid word picture of the position in the Indian sub-continent, contrasting in almost every conceivable way with the United States. He pointed out that the Union of India had a population of 357 million in 1951 (approximately a seventh of the world's total), compared with 235.5 million over the same area in 1901. During the past three decades (that is, after the great influenza epidemic of 1918-19) the absolute increase in numbers over the whole Indo-Pakistan sub-continent has been approximately 50 million per decade. The British Indian Government, Prof. Kuriyan said, handed on a stable administration after a long period of peace and absence of famine. Improvements in medicine, both preventive and curative, have combined to produce a diminishing death-rate of about 2 per cent per annum against a birth-rate of more than 3.

To compensate this growth, there has been no corresponding increase in the resources, which, as in the past, have remained essentially agricultural. From the beginning of this century, there has been a race between population and resources; but since 1921 population has outstripped resources so significantly that in 1951 the total *per capita* production, taking note of all agricultural output, food and cash crops combined, was approximately 450 lb., while the corresponding figure for 1901 was 600 lb. Furthermore, the pressure upon land has increased so considerably that many parts of the country suffer from over-population, tracts with good agricultural resources having as much as 3,000-4,000 persons per square mile. This, in its wake, has led to the emergence of a class of landless labourers whose total numbers are estimated at 45 millions, a group of people who constitute a vulnerable section in the hands of political propagandists.

The real remedies appear to be, first, to increase the average yield of crops, which to-day is appallingly low; second, to enhance the area under cultivation by improvements in irrigation; third, to find employment for the population in avenues other than agriculture; and fourth, to have a conscious and deliberate check on population growth. The last is certainly the most important; but it is doubtful if it is easily practicable in a country like India, where the standards of education are so low and where religious feelings of the bulk of the population have always looked upon a son as a blessing from Heaven and the more sons the greater the security.

Prof. Hilgard O'Reilly Sternberg (Catholic University of Rio) presented a very different picture from Brazil. The extremely rapid increase in population, now more than 56 million, has been due to only a minor extent to immigration over the past century. Development and close settlement, for so long almost confined to a belt within 100-150 miles of the coast, is now taking place with staggering rapidity in many inland centres. New towns on the pioneer fringe within a few years are finding themselves by-passed as new pioneers move on. It is something like the westward expansion of the United States a century ago but with important differences. Social factors often play a greater part than either physical or economic: there is prestige attached to the ownership of large herds of cattle, and none to the raising of crops of wheat. Consequently, as Prof. Sternberg showed by a series of detailed maps based on the 1950 census, expansion of wheat cultivation coincides mainly with areas of German settlement and not necessarily with the most favoured tracts of land.

The chairman suggested that the three speakers illustrated in a remarkable way that there are at least four levels in the population-food problem. One is the somewhat academic global view; the second the national where, for example, the situations in the United States and India are in marked contrast; in the third place, Brazil illustrates the difference between regions, as well as the fourth stage, which is almost a pin-point relationship between an individual farm or settlement and its productive capacity. While the papers showed the

over-riding importance of the physical factors such as climate and soil, economic factors such as farm prices playing an obvious part, the imponderable social factors illustrated by religion and prestige are extraordinarily powerful and persistent.

In the discussion which followed, speakers raised such questions as the increased use of fertilizers and the 'cultivation of the sea'. Three other vice-presidents of the Union were present—Prof. Max Sorre (Paris), Prof. Orlando Ribiero (Lisbon) and Prof. Hans Boesch (Zurich). Prof. Boesch thought the papers emphasized the peculiarly difficult position of the older and more populous countries of Europe relying on their exports to purchase essential food-stuffs from overseas. It is clear, he said, that the great primary producers are not only using more and more of their home production, but are also regarding it as a matter of national prestige to develop their own manufactures.

L. DUDLEY STAMP

¹ *Economic Geog.*, 20, 1 (1953).

ACOUSTICS OF ORTHOPTERA

A SYMPOSIUM on orthopteran acoustics was held at Jouy-en-Josas, near Paris, during April 5-8 under the auspices of the French Ministry of Agriculture (Institut National de la Recherche Agronomique) and the able management of R.-G. Busnel, director of the Laboratoire de Physiologie Acoustique. It was intended both to be international and to be a meeting-ground for the scientific interests—physical, systematic, physiological, ethological and ecological—which touch each other in this field. In the event, although it is to be regretted that Italy, the Iron Curtain countries and the Americas were unrepresented, it provided the first opportunity since the Second World War for discussion of the subject between French, German and British scientific workers, a discussion much facilitated by comprehensive pre-circulation of individual contributions in two or three of their languages.

There has been little recent work on the physiology of hearing in insects; and apart from a useful survey of this part of the field by H. Autrum (Würzburg), the conference divided its time almost equally between papers on three aspects of the subject: the technique of recording and reproducing the sounds produced by insects; the analysis, oscillographic and spectral, of such sounds with attempts to relate the results, on one hand, to the structure and movements of the insect and, on the other, to the confusing and ambiguous terminology already in use; and the function of such sounds in communication between insects of the same species. Since the complete proceedings will be published shortly in French, it would be unprofitable, even if it were practicable, to abstract each contribution and each discussion here. It seems better to give what to one observer were the salient features of the conference as a whole.

The saltatorial Orthoptera, though not the only insects in which communication by sound has been established, are the best known and have shared with the cicadas the ability to interest and exasperate the human hearer for millennia. But it is only very recently that technical equipment has become available for recording, analysing and synthesizing their songs and so making possible an experimental investigation of their meaning. The pioneer observations of Regen and Faber had already established

that different meanings inhered in different varieties of songs; but they had also shown that in certain circumstances a typical response could be obtained to the crudest of imitations while, in others, the insect was not seduced by what appeared to be a perfect copy. This contrast was sharply pointed by two contributions to the symposium. W. Loher (Paris) showed, in an attractive colour-film, how by an imitation made with his own mouth of the 'ordinary song' of *Chorthippus brunneus* (*ci-devant bicolor*), he could attract females of the species on to his person and even on occasion on to his lips. On the other hand, M. and Mme. Busnel described how they had completely failed to obtain a response from the females of *Oecanthus pellucens* by playing back a high-quality record of the song of the male until, with the introduction of a new type of transducer, the ionophone, they began to get positive results. The ionophone, described and demonstrated to the symposium by its inventor, M. S. Klein (Paris), is clearly a technical advance of the first magnitude. It is a completely aperiodic loud-speaker with a flat response up to more than 100 kc/s., and it has a large undistorted power output from what is virtually a point source. It is nevertheless very remarkable that it should be necessary to employ so perfect an instrument in order to make a passable copy of the song of *Oecanthus*, for analysis has confirmed the aural impression that this song is comparatively 'pure', with a fairly simple oscillogram and a relatively narrow spectrum. It is evident that there is still much to be learnt about how the gryllids and tettigoniids detect a spurious copy; and it by no means follows that because some acridiids respond by a tentative approach to an indifferent imitation of the song of their own species, they are unable to distinguish it from the real thing. It is inevitable that comparisons should be made with the experiments of Tinbergen, Lack, Hartley and others, who have shown that a stereotyped reaction can often be elicited from vertebrates by 'models' which correspond only in one or two essential features with the prototype which normally evokes the reaction. Thus small birds which customarily mob tawny owls will mob any dark mottled object of approximately the right size; but they ignore a living barn-owl which is paler, though in other respects it seems to us a much better 'model' of a tawny owl. The determination of what features of the structure of insect songs are 'essential' in this sense to their communicative function is a task for the future, though the investigation is now technically possible. It was interesting and suggestive to find that a comparison of the oscillograms of the 'ordinary song' of *Ch. brunneus* and of Herr Loher's oral imitation disclosed a similarity in structure which was obvious neither to the untutored human ear nor to the spectral analyser.

The majority of vocal saltatoria produce their songs by one or other of two methods which we are accustomed to regard as standard for the group; but D. K. McE. Kevan (Nottingham) gave a substantial list of species employing unorthodox stridulatory devices which he described and which could only be regarded as the result of independent evolution. Unfortunately, little is known of the degree of development of the auditory (tympanal) organs in the heterodox species, or of the importance of stridulation in their life-history; but their existence (many of them are exotic) is a warning not to generalize too widely from the relatively poor orthopteran fauna of Western Europe. B. P. Uvarov

(London) emphasized this danger in pointing out that tympanal organs (ears) are well developed in many dumb acridiids, and that, when the Australian groups are taken into the account, their presence appears to be correlated more closely with the power of flight than with the ability to stridulate. No plausible explanation of this curious paradox has been suggested.

Papers dealing with the sound-field of various types of saltatoria and its relation to their habitat were read by R.-G. Busnel and by P. T. Haskell (London). It is possible to make guesses at the range within which stridulation is an effective means of communication and to account plausibly for some of the characteristic differences of the stridulation patterns of acridiids and tettigoniids in terms of their different habitats, the former insects being relatively densely distributed at ground-level while the latter are scattered in three dimensions. Nevertheless, both these papers made clear the need for better determinations of the auditory threshold in a larger number of species than have yet been attempted. Moreover, as Autrum emphasized in his introductory survey, the division of the auditory function between tympanal organs, sub-genual organs and cerci is a complication of which the consequences are not understood and have scarcely begun to be investigated. One can only agree with the observations of Prof. P. P. Grassé in the address with which he brought the conference to an end: "On ne peut dire que les études faites jusqu'ici sur les sons en tant que facteurs de la structure sociale ou du simple maintien du groupe soient satisfaisantes. . . . Un des mérites du présent Colloque sera d'avoir bien montré la nécessité d'établir les véritables nature et signification des réactions aux stimulations sonores". It must be admitted that this symposium represented seed-time rather than harvest; but it has performed a service of value in stimulating a reorientation of ideas and in indicating lines of research which are likely to be profitable, which are now technically possible, and which, moreover, are certainly relevant to a much wider field than its deliberately restricted agenda might suggest.

R. J. PUMPHREY

SMITHSONIAN INSTITUTION

REPORT FOR THE YEAR 1952-53

THE report of the Secretary of the Smithsonian Institution for the year ended June 30, 1953, to which are appended the usual reports on the United States National Museum, the Bureau of American Ethnology, the International Exchange Service, the National Zoological Park, the Astrophysical Observatory, the National Air Museum and the Canal Zone Biological Area*, points out that almost all the endowments were given for specific purposes and little of the income from the invested funds of the Institution is available for alteration or growth from year to year. Generally, the continuing activities of the Smithsonian Institution have financially remained static during the past twenty years or have even retrogressed. While the national collections in the care of the Smithsonian have increased by

130 per cent since 1934, the number of visitors to its five exhibition buildings has increased by 150 per cent, and the correspondence on scientific and other questions multiplied several times, the man-hours per week available at the Institution have decreased and the appropriation for functions other than staff is 11,000 dollars less than in 1933. Appropriations for the fiscal year 1954 will, however, permit first steps towards the overdue rehabilitation of its exhibitions and the renovation of some of its buildings, though funds for continued modernization and renovation will be urgently required in succeeding years as well as plans for new buildings.

At the end of 1952 the activities of the Institute of Social Anthropology were terminated, and anthropologists remaining on its staff were transferred to the Institute of Inter-American Affairs. Systematic researches of the anthropologists of the Bureau of American Ethnology included Dr. M. W. Stirling's archaeological work in Darien and on the islands of the Gulf of Panama, Dr. H. B. Collins's studies on the Eskimo and arctic anthropology, Dr. J. P. Harrington's studies of the Chumash Indians of the Santa Barbara Channel region, California, and those of Dr. P. Drucker of Meso-American archaeology. In the investigations of the River Basin Surveys carried out by the Bureau in co-operation with the National Park Service and the Bureau of Reclamation of the Department of the Interior, the Corps of Engineers of the Army Department and various State and local institutions, greater emphasis continued to be laid on excavation now that survey has largely caught up with the general programme. Of the 3,469 archaeological sites located and recorded by the survey parties, 852 have been recommended for excavation or limited testing. Already 172 preliminary appraisal reports have been distributed, and excavations made in 42 reservoir projects located in 17 States. Paleontological surveys have been made in 121 reservoir areas, and archaeological work has also been done in 88, while the remaining 33 will be visited by archaeological parties. Already 273 reservoir basins, including those where archaeological studies are still to be made, have been surveyed.

The collections of the National Museum increased by more than 1,607,000 specimens during the year, bringing the catalogue entries to nearly 35 million. Exploration and field-work during the year included C. O. Handley's observations and collections of mammals in the Kalahari desert region of north-eastern South West Africa, Dr. A. Wetmore's studies on the distribution of bird life in Panama, H. G. Deigman's ornithological work in Thailand, studies of coral-atoll ecology in Tahiti and on Raroia Atoll, and searches for invertebrate and vertebrate fossils by three parties at Adair, Oklahoma, in the Guadalupe Mountains of western Texas, in north, east and south Mexico and in south-central Wyoming. Accessions to the National Zoological Park numbered 810, bringing the net count of animals at the end of the year to 2,741, but there was a slight decrease in the number of visitors, who totalled about 3,231,000.

At the Astrophysical Observatory the manuscript of Vol. 7 of the *Annals of the Observatory*, covering its research during 1939-52, was completed and sent to press late in the year. A thorough study of the silver-disk pyroheliometer was completed in April 1953. Tape exposures to total sun and sky radiation continued at Montezuma, Chile, where a new modern seismometer is now being installed, and at Table Mountain, California, the permanence of the con-

* Smithsonian Institution. Report of the Secretary and the Financial Report of the Executive Committee of the Board of Regents, for the Year ended June 30, 1953. (Smithsonian Publication 4141.) Pp. x + 160 + 6 plates. (Washington, D.C.: Government Printing Office, 1953.)

stants of the Smithsonian double-tube, water-flow standard pyroheliometer and of the sub-standard silver disk pyroheliometer *S.I.5* has been confirmed. The researches of the Division of Radiation and Organisms continue to be concerned chiefly with the physiological and biochemical processes by which light regulates the growth of plants and the mechanisms of the action of the auxin type of growth hormone. Investigations of the effect of plant-growth regulators on the salt exchange of plants indicated that high salt-low carbohydrate plants lose salt more rapidly when treated with ammonium 2:4-dichlorophenoxyacetate, while low salt-high carbohydrate plants absorb salt less rapidly compared with untreated plants.

Of the seven hundred visitors to the Canal Zone Biological Area, fifty-seven were scientific workers who used the facilities of the station, considerably improved during the year, chiefly for biological and photographic studies. The 1,021,938 packages of government scientific and literary publications handled by the International Exchange Service during the year, an increase of 20,324 packages, included consignments to all countries except China, North Korea and Rumania. A grant of 6,000 dollars towards rising transport costs was received from the National Science Foundation. The Service now dispatches abroad sixty-three full and forty-two partial sets of United States official publications in exchange for the official publications of other Governments.

WOOL INDUSTRIES RESEARCH ASSOCIATION

REPORT FOR THE YEAR 1953-54

THE report of the Director of Research of the Wool Industries Research Association for 1953-54* expresses the view that the statutory levy for research, which has now been in operation for two years, has both increased the interest of members and also enabled the Wool Textile Research Council to clarify the relation of research at the universities and technical colleges to that of the Association. The pilot-scale scouring plant was completed towards the end of the year and has given results well up to commercial standard. Data have been obtained on the possibility of alkali damage to wool during commercial scouring. A prototype of the automatic controller for the woollen card designed in the Association's laboratories some years ago is undergoing trials in a mill and seems to be suitable for commercial use; and a second controller, which may be particularly suitable for cards with ball and bank feeds, is also under trial. Commercial development of the Raper drawing system, incorporating auto-levellers, has now been taken up, and a most encouraging number of firm orders has been placed by British spinners; a great deal of the early work on this new system was done in the Association's laboratories. Much new information about the drafting process has been obtained by the use of radioactive tracers, and considerable progress has also been made in an attempt to understand theoretically how tensions are generated in yarns being drawn from packages, and

how this tension should vary with the dimensions of the package and the position of the twist through which the yarn must pass.

In chemical technology 449 investigations were carried out on behalf of member firms. Scouring experiments continued, and a large-scale trial demonstrated that bulk removal of cellulose acetate fibre from rags is technically feasible. The practicability of dyeing wool at high temperatures without undue damage to fibres has been confirmed, provided the pH of the dye liquor and the time of treatment are kept within limits. Experience has shown that the Association's fineness meter, based on the air-flow method, is quick and reliable and that the accuracy in the mean fibre diameter of tops is at least as high as that obtained with a projection microscope. A rapid method of comparing the strength of two yarns has been devised, which can be used where no strength machine is available. Work in the Biology Department on Scots blackface, Herdwick and Suffolk breeds of sheep has emphasized the importance of the secondary to primary follicle ratio in the development of fine wools, and the effect of breeding and of nutrition on this ratio is being studied.

The use of starch columns together with fraction cutters for quantitative estimation of amino-acids by colorimetric and radioactive methods continued, and by the method of hydrazinolysis the carboxy terminal end-groups of wool have been found to be serine, glycine, threonine and alanine. A study of the effect of dry chlorination on dyed nylon has been completed. Experiments with textiles and ion-exchange resins have shown the electrolytic nature of charge separation by contact between dissimilar polar polymers, the sign of the charge being determined by the excess of freely diffusible ions in the polymer. Complete X-ray data have been obtained for the hydrochloride and hydrobromide of glycol-L-alanine, and a Fourier projection has been determined which gives an accurate picture of the atomic arrangement.

ROYAL SOCIETY DEPOSITORY OF UNPUBLISHED MATHEMATICAL TABLES

THE following is a list of accessions to the Royal Society's depository of unpublished mathematical tables since the publication of the last list in *Nature* (171, 1140; 1953):

(22) Factorisation des nombres $2N^4 + 1$, $N < 1000$ (A. Gloden);

(23) Factorization of $N^4 - 3n^4 - 1$, $0 < N < 1000$ (A. Ferrier);

(24) High-accuracy square- and cube-roots (D. F. Ferguson, O. E. Gwyther and J. O. P. Miller);

(25) A solution of the equation $(y')^2 = y y'$;

(26) Table of

$$F(\beta, \rho) = \frac{2}{\sqrt{\pi}} \frac{\exp(-\rho^2)}{\beta^2} \int_0^\beta I_0(2\rho\eta) \exp(-\eta^2) \eta d\eta;$$

(27) Tables of $F(x) = 2x \sum_{n=0}^{\infty} \{x^2 + (2n+1)^2\}^{-3/2}$ and of $x^{-1}F(x)$;

(28) Table of $G(x) = 6x^2 \sum_{n=0}^{\infty} \{x^2 + (2n+1)^2\}^{-5/2}$;

* Wool Industries Research Association. Publication No. 199: Report of the Director of Research for 1953-54. Pp. 32. (Leeds: Wool Industries Research Association, 1954.)

(29) Tables of

$$f(x) = \sum_{n=0}^{\infty} (-)^n (2n+1) \{x^2 + (2n+1)^2\}^{-1/2}$$

and of $x f(x)$;

(30) Table of

$$f(x, y) = \frac{1}{2\pi} \int_0^{2\pi} \exp(-x \cos \theta - y \cos^2 \theta) d\theta;$$

(31) Tables associated with $\int_0^{\pi} (\cot u + \mu \sin u)^{-1} du$;

(32) Tables of $\int_0^{\pi} \exp(-2\pi i r) dt$

and $\int_0^{\pi} r^{-1} \exp(-2\pi i r) dt$, where $r^2 = a^2 + t^2$;

(33) Tables of integrals associated with the zeros of $\tan z + \tanh z$;

(34) Values and contours of

$$\int_0^{\infty} [\exp(-k) \{J_0(kx) \cosh(ky) - 1\} / \sinh k] dk;$$

(35) Table of

$$f(x) = \exp(-x) \int_0^{\pi/2} \exp(x \cos \theta) \sin^2 \theta d\theta$$

(36) Zeros of the first ten Laguerre polynomials and the corresponding Christoffel numbers;

(37) Tables of $\int_0^{\infty} \exp\{-k^{-1/2} u + i(2ku - u^2)\} du$ for $k = \frac{1}{2}, \frac{1}{3}, 1, 2, 4$ and 8 ;

(38) Tables for the summation of trigonometrical series;

(39) Tables of the incomplete Airy integral;

(40) Tables of the functions associated with the Airy integral for complex arguments;

(41) Tables of the function $O(m, \mu; x)$.

Tables 25-29 were compiled by the Admiralty Research Laboratory; Tables 30-41 by the Admiralty Computing Service.

Further information about these tables may be obtained on application to the Assistant Secretary, The Royal Society, Burlington House, London, W.1.

be integrated, and an opaque mask placed on the illuminated table represents the domain of integration. The photo-electric cell current, which depends upon the incident light energy, can, by suitable calibration, be interpreted as a surface integral. The relationship between the (non-uniform) light distribution on the table and the height and characteristics of the cell is such that, in the absence of the grating, an opaque mask of given area on the table screens the cell from a fixed quantity of light, independent of the position of the mask on the table. Thus without the grating the instrument would function as a planimeter.

In the instrument which is now in use at Fort Halstead, the light-diffusing table is illuminated from beneath by twenty lamps arranged in a ring: the lamps are fed by alternating current and have a 20 per cent modulation. Two types of photo-plate grating, representing the function to be integrated, have been used with equal success, namely, high-contrast and silver deposit on glass plates, both of full-plate size ($8\frac{1}{2}$ in. $\times$ $6\frac{1}{2}$ in.). The light transmitted through any small element of area on the grating is proportional to the value assumed in a corresponding element by the function represented. The plates used (see Fig. 1) have discrete patterning small enough to give sensibly continuous representation of the (continuous) function over the domain of integration. The photo-electric cell is a caesium vacuum cell with a 1-in. diameter light-diffusing 'eye' at a fixed height above the table. The cell current follows the lamp emission, consisting of a constant component plus a ripple. This current is passed to a unit in which the constant component is blocked by a condenser prior to injection into the grid circuit of the first valve. This governs the valve current, which therefore follows the lamp emission and which passes through a sensitivity control to further amplification, rectification and a galvanometer. There is a maximum amplification of 20,000 from cell current to galvanometer current. Thus the galvanometer readings, which are interpreted as surface integrals, are

THE A.D.E. PHOTO-ELECTRIC INTEGRATOR

By J. R. LOWE

Fort Halstead, Nr. Sevenoaks, Kent

THE instrument described in this article is capable of evaluating surface integrals of any function over a domain with any (possibly irregular) boundaries not containing poles of the function. It is necessary to prepare suitable photo-plate representations of the function, together with opaque masks representing the domain of integration: these preparations will be merited in cases such as the survey task with which we were concerned, which entailed the evaluation of very many surface integrals within irregular boundaries. The accuracy obtainable with the instrument is not yet precisely known, as it is still in the development stage, but the order of errors encountered at present is mentioned later.

In essence, the instrument consists of a light-diffusing table, illuminated from beneath, above which a photo-plate grating and a photo-electric cell are arranged. The grating represents the function to

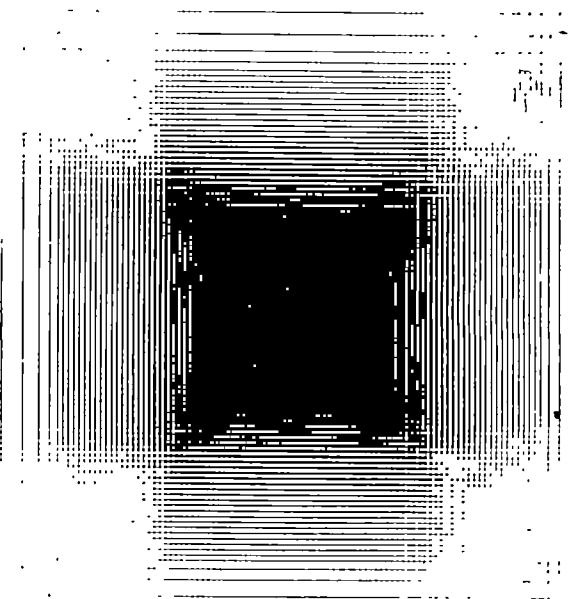


Fig 1

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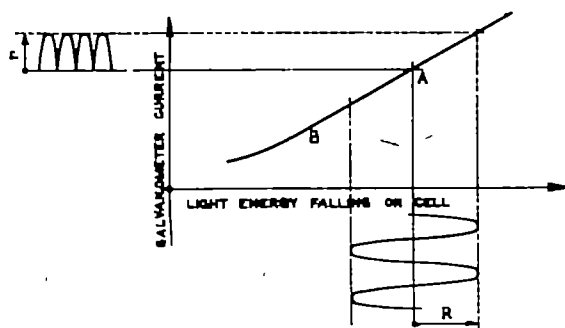
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Fig. 2

responsive only to ripple; hence, under normal working conditions, slow variation of ambient light can be tolerated. By normal working conditions we imply that the obscuration of the cell, due to the grating-mask combination, is not too great.

This proviso will be understood from Fig. 2, which depicts the instrument characteristic at the low-illumination end of the curve. In this region there is a departure from linearity due mainly to the combined effects of the cell and rectifier characteristics. The constant component of illumination fixes the operating point A , while the ripple of amplitude R is followed by the rectified current of amplitude r . Hence, provided that A remains on the straight part of AB , which has constant slope, the galvanometer response is a true image of the ripple. If, however, the steady illumination is weak enough (that is, the obscuration great enough), then the operating point will move to B and the galvanometer response will be distorted. We can, of course, calibrate for any operating point, but only when this lies in a region of constant slope can (slow) variations of ambient light be tolerated; in practice, where obscuration is great, additional steady illumination between grating and cell is provided to keep the operating point up.

The instrument has been used successfully to give integrals of a bivariate-normal distribution function over a domain with irregular boundaries. The initial work consists of (i) the preparation of the gratings and masks, (ii) the matching of these to the conditions of the problem, that is, the initial instrument settings, and (iii) calibration of the instrument. These tasks complete, the evaluation of the surface integrals proceeds very rapidly and entails merely placing the masks in position and reading the galvanometer. Calibration is very simple; one merely brings the galvanometer to zero, with a clear table of known proportions of the probability distribution and observes the corresponding galvanometer readings.

The present method of preparing the gratings is to draw diagrams, to a large scale, consisting of alternate bands of black and white to represent a univariate normal distribution. Photographic superposition of two such diagrams, to a reduced scale and with their bands perpendicular, then gives the required grating. Thus, consider a plain white sheet divided into narrow vertical strips each of width $L + D$. We locate the mean of the normal distribution at the central strip and we wish to blacken a band in each strip (for example, that distant σ from the mean measured perpendicular to the strips) such that the remaining white band-width, L , is proportional to the value assumed by the normal distribution (at distance σ from the mean). That is to say, we require:

$$\frac{L}{L+D} = K \exp\left(\frac{-x^2}{2\sigma^2}\right).$$

If, for simplicity, we choose zero blackening at the mean, that is, we choose $D = 0$ when $x = 0$, then we have:

$$\frac{L}{L+D} = \exp\left(-\frac{x^2}{2\sigma_1^2}\right).$$

Likewise, for the second diagram we have:

$$\frac{L'}{L' + D'} = \exp \left(-\frac{y^2}{2\sigma_y^2} \right).$$

If $L + D = L' + D'$, then the strips in the above diagrams when superimposed define a system of small squares. Consider the square located at (x, y) : the proportion of white surface in this square is clearly

$$\frac{L}{L+D} \times \frac{L'}{L'+D'} = \exp \left(-\frac{x^2}{2\sigma_x^2} - \frac{y^2}{2\sigma_y^2} \right).$$

Thus, when a photo-plate grating is prepared from these diagrams, the light energy arriving at the photo-electric cell, via the unblacked areas of the grating, is governed by the binormal distribution function. Fig. 1 depicts a negative of a binormal distribution grating for which $\sigma_1 = \sigma_2$.

The accuracy obtained with the instrument in recent work is shown by the following results. Using square marks to denote the domain of integration, a series of integral values were obtained of magnitude 0 to 1 (they were probabilities). These values were compared with correct values calculated from error function tables, and the standard deviation of the discrepancies was 0.002. A more adequate (and much longer) statement about accuracy could be made, but this would not be reasonable as our work to date has been of a preliminary nature only.

Acknowledgment is due to Mr. L. Z. Solomides, of the Research and Development Department of London, Ltd., Anerley, London, S.E.20, for the successful development of this instrument; also to the Chief Scientist, Ministry of Supply, for permission to publish this article.

EFFECT OF NUCLEIC ACIDS ON PROTEIN SYNTHESIS AND AMINO-ACID INCORPORATION IN DISRUPTED STAPHYLO- COCCAL CELLS

By DR. E. F. GALE, F.R.S., and JOAN P. FOLKES
Medical Research Council Unit for Chemical Microbiology,
Department of Biochemistry, University of Cambridge

IT has frequently been suggested in recent literature that nucleic acids have an organizing or controlling role in protein synthesis. These suggestions arise from consideration of three main types of experimental evidence: that the rate of growth or of protein synthesis in a variety of cells can be correlated with the nucleic acid content of those cells¹; that changes in the activity or composition of bacterial cells as a result of the action of transforming factors or bacteriophages are associated with addition

of deoxyribonucleic acid to the cells³; and that no convincing demonstration of protein synthesis has been obtained under physiological conditions by proteolytic enzymes. The further suggestion has been made that nucleic acids act as templates accomplishing the organization of amino-acid residues within protein structures^{3,4}. But any proof of the part they play, let alone its mechanism, awaits the preparation of an experimental system which can synthesize protein and on which an effect of nucleic acids can be demonstrated. Such a system has now been obtained by disruption of suspensions of *Staphylococcus aureus* by exposure to supersonic vibration.

Preparation of Disrupted Cell Material

Staphylococci are harvested while in the stage of active growth after 13 hr. incubation at 30°, washed once in water and made into thick suspension (40 mgm. dry weight of cells/ml.) in 10 per cent sucrose solution buffered with 0.03 M phosphate buffer at pH 6.5. The suspension is then subjected to supersonic vibration of 25 kc./sec. generated by a 500-W. Mullard magnetostrictor oscillator, the transducer-cup assembly being cooled in ice throughout the exposure. The time of exposure varies with the type and efficiency of the assembly used; in a typical case, exposure for 10–15 min. at full power reduced the viable count to 0.1 per cent of the original, while complete disintegration of the cells took place in approximately 35 min. If the material obtained after 20–25 min. exposure in such an assembly is centrifuged at 800 g for 7 min., any unbroken cells are removed; the supernatant is turbid and the greater part of the sedimentable material responsible for this turbidity can be centrifuged down in 20 min. at 4,000 g. The sediment so obtained, after one washing in phosphate buffer at pH 6.5, provides the disrupted cell material used for these studies and, on a dry weight basis, represents approximately 3 per cent of the original cell suspension. Electron microscope examination of the sediment shows that it consists of broken cell envelopes each containing a small round mass of electron-dense material in the centre. Chemical analysis shows that the 'cells' have lost approximately half their protein and nucleic acid at this stage. They are non-viable and have no respiration; they are, however, able to form acid from glucose and to use adenosine triphosphate in the presence of hexosediphosphate as energy source for amino-acid incorporation or protein synthesis processes⁵.

Nucleic acid can be removed from these 'cells' by extraction with M sodium chloride or incubation with ribonuclease or deoxyribonuclease. The usual procedure adopted for such resolution has been to incubate the preparation in M sodium chloride for 1 hr. at 37°; this treatment removes approximately 30 and 55 per cent of the remaining protein and nucleic acid, respectively. Incubation with ribo- or deoxyribo-nuclease (100 µgm./ml.) for 1 hr. at 37° removes approximately 75 per cent of the remaining nucleic acid. Electron microscope examination of the disrupted cell material after such treatment shows that the electron-dense material has largely disappeared and that the majority of the 'cells' consist of cell envelopes with only traces of electron-dense substance in their centres. The amount of nucleic acid that can be removed from the preparation increases with the time of exposure to supersonic

vibration; material obtained after 30 min. exposure can be rendered almost free from nucleic acid in this way.

Incorporation of ¹⁴C-labelled Glutamic Acid

If the disrupted cell material is incubated with ¹⁴C-labelled glutamic acid, adenosine triphosphate and hexosediphosphate, labelled glutamic acid becomes incorporated into the protein fraction of the 'cells'. In the absence of other amino-acids, this incorporation ceases after 90–120 min. incubation (see Fig. 1) and the incorporated radioactive glutamic acid can be partially removed by subsequent incubation of the preparation with adenosine triphosphate, hexosediphosphate and unlabelled glutamic acid⁶. It appears that this incorporation takes place as a result of an exchange reaction between glutamic acid residues of the protein and glutamic acid (possibly after activation by adenosine triphosphate) in the medium^{6,7}; the process is not accompanied by any measurable synthesis of protein. It can be calculated that, under optimal conditions, some 5–8 per cent of the total protein glutamate residues undergo such exchange reactions. *Staphylococci* cannot synthesize protein unless a wide variety of amino-acids is provided in the incubation mixture⁴; if a complete mixture of the naturally occurring amino-acids is added to the incubation mixture, incorporation of ¹⁴C-labelled glutamic acid by disrupted cells continues in a linear fashion for some hours (as shown in Fig. 1) and is accompanied by a small but parallel increase in the protein-nitrogen content of the preparation⁷.

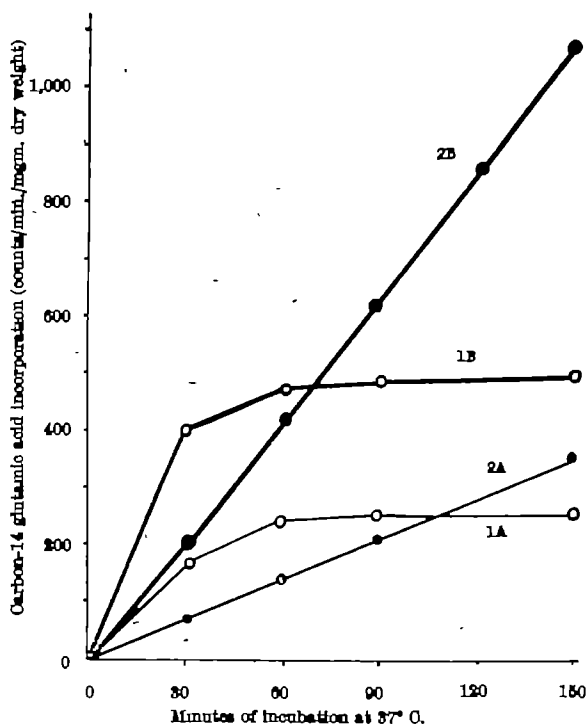


Fig. 1. Course of incorporation of ¹⁴C-labelled glutamic acid by disrupted cell preparation. Curve 1A: preparation incubated with adenosine triphosphate, hexosediphosphate and α-carboxy-¹⁴C-glutamic acid. Curve 1B: as for 1A with addition of 0.1 mgm. staphylococcal nucleic acid/ml. Curve 2A: as for 1A with addition of complete mixture of amino-acids. Curve 2B: as for 1B with addition of complete mixture of amino-acids. Counts carried out on protein fraction of preparation in all cases.

If nucleic acid is removed from the disrupted cells by any of the methods mentioned above, the ability of these cells to incorporate glutamic acid, whether in the presence or absence of an amino-acid mixture, decreases markedly, and this ability is restored by addition of nucleic acid prepared from the soluble portion of the supersonic disintegration by the method of Jones⁸. The staphylococcal nucleic acid has been separated into deoxyribo- and ribo-nucleic acid fractions by the method of Dutta, Jones and Stacey⁹ and the fractions cleaned up by treatment with the appropriate nucleases (deoxyribonucleic acid fraction treated with ribonuclease), followed by precipitation of the sodium salts with ethanol, solution in water and dialysis against distilled water. The incorporation of ¹⁴C-glutamic acid under exchange conditions is markedly accelerated by addition of either ribo- or deoxyribo-nucleic acid¹⁰, a system containing 1.0 mgm. dry weight of disrupted cells/ml. being completely activated by 0.08 mgm. ribo- or 0.04 mgm. deoxyribo-nucleic acid/ml.

Exchange reactions are not confined to glutamic acid but take place to varying extents with all amino-acids tested⁴. However, when the effect of resolution and reactivation by nucleic acids was investigated, it was found that the results varied greatly with the amino-acid tested. For example, ribonucleic acid activation of a salt-resolved preparation towards incorporation of glycine, aspartic acid, glutamic acid or alanine, each tested alone, was found to be 550, 210, 150 and 0 per cent, respectively. No procedure yet adopted has resulted in a demonstrable effect of nucleic acid on incorporation of alanine. Fig. 1 shows the progress of incorporation of ¹⁴C-glutamic acid in a salt-resolved preparation with (curves marked B) and without added nucleic acid (curves marked A) when incubation takes place either with glutamic acid as the only amino-acid present (condition for curves marked 1) or with a complete mixture of amino-acids including ¹⁴C-glutamic acid (curves marked 2).

Whether the amino-acid mixture is present or not, addition of nucleic acid has a marked effect on the incorporation, and it seemed possible that the effect shown in curves 2A and 2B might represent an action of nucleic acid on synthesis of protein in the disrupted cell preparation. If this were the case, similar results should be obtained under the conditions of curves 2A and 2B, whichever of the amino-acids in the mixture were labelled with carbon-14. Accordingly, an experiment was carried out under these conditions with either glycine or aspartic acid or glutamic acid or alanine labelled in parallel samples; it was found that the effect of nucleic acid again varied with the amino-acid the incorporation of which was being measured; thus the incorporation of glycine under conditions shown by curve 2B took place, in one experiment, at a rate 120 per cent greater than that under conditions of curve 2A, while parallel measurements of the incorporation of alanine showed no effect due to the addition of nucleic acid. It is clear that such studies of the incorporation of labelled amino-acids cannot be used as a means of studying the action of nucleic acids on protein synthesis as such. This confirms the similar conclusion previously drawn from studies of the incorporation of labelled amino-acids in intact staphylococci^{4,11}.

Synthesis of Protein and Specific Enzymes

After the results described above were obtained, it was decided to abandon the isotope method for

studying protein synthesis and to investigate, instead, changes in protein-nitrogen and in certain enzymes found to be active in the preparations used. The enzyme systems so far investigated (see Fig. 2) are catalase¹², enzymes involved in the formation of acid from glucose¹³, and the adaptive enzyme, β -galactosidase¹⁴. The disrupted cell preparations used were obtained by exposing staphylococci as described above to supersonic disintegration for 25–30 min. and then resolving the active fraction by extraction with *M* sodium chloride. The preparation was incubated at a final suspension density of 0.3–1.0 mgm. dry weight/3.5 ml. in a salt solution buffered at pH 6.2 containing 2 μ moles adenosine triphosphate/ml., 18 μ moles hexosediphosphate/ml. and a complete mixture of amino-acids¹⁵ with each component at a final concentration of 0.5 mgm./ml. To various samples, suitable amounts of deoxyribo-nucleic acid, ribonucleic acid or a mixture of purines and pyrimidines¹⁶ were added; the concentrations of nucleic acids giving optimal responses varied from experiment to experiment between the limits of 0.02 and 0.1 mgm./ml., and experiments were usually conducted over this range of each nucleic acid; the purine-pyrimidine mixture was added at a final concentration of 25 μ gm. of each component/ml. Incubation was carried out at 37° in centrifuge tubes for 1–2 hr., and the disrupted cells then centrifuged down for analysis and enzyme determinations.

Clearer results were obtained with preparations from which nearly all nucleic acid had been removed; in such preparations it has been possible to show a significant development of the three activities investigated and to demonstrate effects of nucleic acid on such development. In some preparations the rate of production of acid from glucose was negligible; but this activity could be developed by incubation in the presence of amino-acids and either nucleic acid or the purine-pyrimidine mixture, amino-acids alone having little effect (see Fig. 2). The catalase activity could be doubled by incubation for 90 min. under appropriate conditions while, since the original cells had been grown in the absence of lactose or galactose, the preparation was initially devoid of β -galactosidase activity. Conditions leading to the development of the three activities are summarized in Fig. 2; in all cases appropriate controls have been carried out, though not shown in Fig. 2, and the development was abolished either if the amino-acid mixture were omitted or if 30 μ gm. chloramphenicol (which inhibits protein synthesis¹⁷)/ml. were added to the incubation mixture. Consequently, it is a reasonable assumption that the activities develop as the result of protein synthesis. Increases in protein-nitrogen of the preparation are not as marked as the increases obtained for some enzymes, probably because the preparation contains non-functional protein in the cell-wall, etc. Incubation for 90 min. with amino-acid mixture alone and in the presence of deoxyribo- or ribo-nucleic acid, or purine-pyrimidine mixture, gave rise respectively to 2, 21, 31 and 20 per cent increase in protein-nitrogen.

The development of the enzyme system producing acid from glucose is markedly stimulated by the presence of the purine-pyrimidine mixture and somewhat less stimulated by the presence of either deoxyribo- or ribo-nucleic acids; the addition of either of the nucleic acids together with the purine-pyrimidine mixture gives less stimulation than the latter alone. This is a complex enzyme system, and

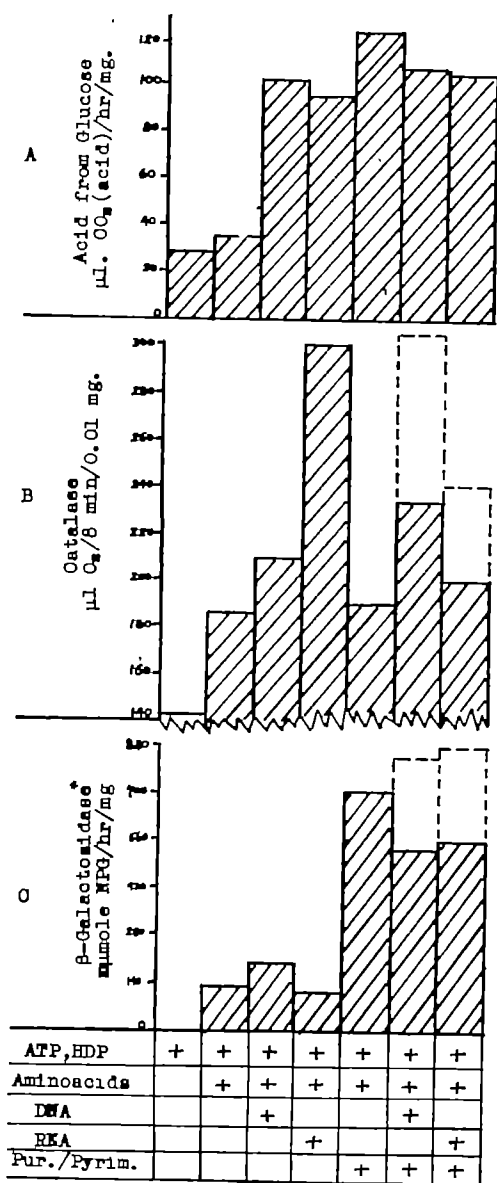


Fig. 2 Development of (A) enzyme system forming acid from glucose, (B) catalase, and (C) β -galactosidase in disrupted cell preparations. Conditions of incubation as indicated with quantities as in text. Time of incubation: A, 90 min.; B, 90 min.; C, 120 min. * 2 per cent galactose present in incubation mixture for experiments on β -galactosidase development. Broken lines represent occasional atypical results.

more clear-cut results have been obtained with the single enzymes studied, catalase and β -galactosidase. Increase in catalase is markedly affected by ribonucleic acid only, deoxyribonucleic acid and the purine-pyrimidine mixture having little effect, while the latter is sometimes found to depress the formation of catalase below that obtained with amino-acids alone. The addition of the purine-pyrimidine mixture to ribonucleic acid decreases the effect of the acid; in some cases the mixture accelerates the effect of deoxyribonucleic acid alone, and on one occasion (as shown in Fig. 2) the two together gave a slightly greater stimulation than ribonucleic acid alone.

The development of the adaptive β -galactosidase system is particularly interesting. In no case has it

been possible to develop this activity in the absence of a suitable inducer such as galactose. In the presence of galactose, amino-acid mixture and the purine-pyrimidine mixture, there is a rapid formation of β -galactosidase in the preparation and the development continues in a linear fashion for up to 3 hr. In 'cell' preparations which are only partially resolved, the presence of amino-acid mixture gives rise to formation of enzyme at a rate 30-45 per cent of that obtained by the further addition of the purine-pyrimidine mixture. With 'cells' at this stage, neither ribo- nor deoxyribo-nucleic acid has any significant stimulating effect although, on three occasions out of twelve tests, a high concentration (0.3 mgm./ml.) of ribonucleic acid obtained from organisms grown in galactose has increased the effect of the purine-pyrimidine mixture although it has had no action in the absence of the latter. In highly resolved preparations, the enzyme formation due to amino-acids alone is small, while the response to the purine-pyrimidine mixture also decreases and can be abolished by treatment of the preparation with deoxyribonuclease. Addition of 0.015 mgm. deoxyribonucleic acid/ml. now significantly stimulates enzyme formation in the presence of amino-acids and restores the response to the purine-pyrimidine mixture to normal; deoxyribonucleic acid extracted from cells grown in galactose has proved two-three times more active than deoxyribonucleic acid extracted from cells grown in glucose. The presence of ribonuclease in such cases abolishes the response to both deoxyribonucleic acid and the purine-pyrimidine mixture.

Incubation of intact *staphylococci* with glucose, amino-acid mixture and the purine-pyrimidine mixture gives rise to nucleic acid synthesis within the cells, the presence of the amino-acid mixture being an essential part of the system¹². The effect of the purine-pyrimidine mixture on the development of certain enzymes in disrupted cell preparations suggests that these preparations may also be able to synthesize nucleic acid under the conditions used. This has been tested by adding ¹⁴C-labelled uracil or thymine to the purine-pyrimidine mixture and determining the incorporation of radioactivity into the nucleic acid of the preparation. No incorporation of thymine was found in any of the conditions tested. When disrupted cells were incubated with ¹⁴C-uracil, adenosine triphosphate, hexosediphosphate and either the purine-pyrimidine mixture or amino-acids separately, incorporation was insignificant; when the purine-pyrimidine mixture and amino-acids were present together, incorporation took place at a rate corresponding to approximately 3 μ mole uracil/hr./mgm. dry weight of preparation; when galactose was added (as for the development of β -galactosidase) in the presence of amino-acids and the purine-pyrimidine mixture, the rate of uracil incorporation increased five-six times. It appears that the disrupted cells can synthesize ribonucleic acid from the purine-pyrimidine mixture and other components of the medium under suitable conditions.

Action of Penicillin on Enzyme Formation

Table 1 shows the effect of the addition of penicillin to the incubation mixture during the development of the various enzyme systems studied. The development of catalase or the acid-producing system from glucose is insensitive to penicillin unless the concentration of the antibiotic is taken to very

Table 1. EFFECT OF PENICILLIN ON DEVELOPMENT OF ENZYME ACTIVITIES IN DISRUPTED CELL PREPARATION

Penicillin concentration (int. unit/ml.)	Per cent inhibition of development of		
	Catalase	Acid formation from glucose	β -Galactosidase
1	4	0	60
30	5	0	78
300	13	0	83

high values; this finding agrees with that previously recorded for the effect of penicillin on the synthesis of cellular protein in intact *staphylococci*¹². The development of β -galactosidase is, however, highly sensitive to penicillin, being 60 per cent inhibited by a concentration of 1 international unit of penicillin/ml. The sensitivities of the syntheses do not appear to depend upon the conditions promoting the formation of the enzymes; thus the sensitivity of either catalase or β -galactosidase development is significantly the same whether formation takes place in the presence or absence of ribo- or deoxyribo-nucleic acid or the purine-pyrimidine mixture. The incorporation of ¹⁴C-uracil which takes place under the conditions of optimal synthesis of β -galactosidase is 65 per cent inhibited by 30 int. units penicillin/ml., whereas that which occurs in the absence of galactose is inhibited to an extent of less than 15 per cent.

Role of Nucleic Acids In Protein Synthesis

Nucleic acids play a part both in the synthesis of proteins and in the incorporation of labelled amino-acids into preformed protein in the disrupted *staphylococci* preparations used in this work. When a single amino-acid is supplied in the medium, it appears that exchange reactions may occur between that amino-acid and corresponding residues in certain of the cell proteins as long as nucleic acid is present. It would appear that either deoxyribo- or ribo-nucleic acid can render amino-acid residues exchangeable, but it is not yet possible to say whether the same or different proteins are involved in the two cases. No clear explanation can be given of the differing degrees of 'resolution' obtained with incorporation of different amino-acids, unless the activation of amino-acid residues which renders them exchangeable is accomplished by specific fragments of nucleic acid, and some of these fragments are more readily removed or damaged than others.

When all the necessary amino-acids are available and conditions are suitable for protein synthesis, the nature of the protein produced would again appear to be determined by nucleic acids. The experimental facts outlined above could be fitted into a mechanism of protein synthesis occurring along the lines of the following scheme, for which no originality can be claimed: the initial organizing structure or template is either deoxyribonucleic acid or a protein complex containing that acid; this structure is not capable of the synthesis of new protein (although it may bring about exchange reactions in the protein portion), but acts as an organizer for the synthesis of ribonucleic acid; once ribonucleic acid has been constructed, then neo-protein synthesis can take place at a rate dependent upon the amount of specific ribonucleic acid catalyst present. It may be that it is the ribonucleic acid which collects, organizes and orientates amino-acid residues before they split away as protein, or it may be that deoxyribonucleic acid combines with and organizes amino-acid residues which cannot combine into a peptide chain until they

have been taken over by the corresponding ribonucleic acid. The comparative effectiveness of ribonucleic acid and a purine-pyrimidine mixture in promoting specific protein synthesis in disrupted cell preparations would then depend upon (1) the ease of synthesis of the specific ribonucleic acid from the purine-pyrimidine mixture, and (2) the stability of the ribonucleic acid once synthesized. Thus, in the case of catalase, the specific ribonucleic acid appears to be stable but not readily synthesized, whereas the formation of β -galactosidase would be explicable if the corresponding ribonucleic acid syntheses were rapid but the product unstable in the absence of inducer. The initiatory role of deoxyribonucleic acid in the case of β -galactosidase formation is shown by the disappearance of response to amino-acids and the purine-pyrimidine mixture in highly resolved preparations treated with deoxyribonuclease, and recovery of response by addition of small amounts of deoxyribonucleic acid. The response to the purine-pyrimidine mixture is accompanied by synthesis of ribonucleic acid, and its essential role in β -galactosidase formation is shown by the loss of response to the purine-pyrimidine mixture and deoxyribonucleic acid in the presence of ribonuclease.

It has been previously shown that penicillin, at growth-inhibitory concentrations, inhibits the incorporation of specific amino-acid residues (under exchange conditions), and it has been suggested that this inhibition results from a blocking of specific interactions between nucleic acids and proteins which would lead, in the growing cell, to failure of the formation of specific proteins¹³. In the *staphylococci* used for this work, β -galactosidase is an example of a protein the formation of which is inhibited by penicillin. The inhibition is again accompanied by inhibition of synthesis of ribonucleic acid.

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GENETIC POLYMORPHISM IN THE RABBIT IN TASMANIA

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THE rabbit (*Oryctolagus cuniculus*) was introduced into Tasmania soon after the first settlement in 1803. It was first recorded wild in large numbers on a few estates in the lower midland pastoral areas north of Hobart in 1827¹. During the next fifty years it spread over the midlands pastoral region, occupying country with open eucalypt savannah

vegetation and a rainfall of 20-30 in. Towards the end of the nineteenth century it colonized the central plateau region around Great Lake, a region more than 3,000 ft. above sea-level and with a rainfall of 30-40 in. The north-west coastal region and the north-east mountains were first colonized extensively during the past 30-40 years. To-day the rabbit can be found over most of the eastern two-thirds of the island.

In the west the spread of the rabbit has been limited by natural ecological barriers. Apart from a coastal belt about thirty miles wide running along the north-west coast, there are no rabbits in the western third of the island. This area is approximately limited by the 60-in. isohyet. Within this area the main plant communities are dense rain forest with *Nothofagus*, *Atherosperma*, *Anodopetalum*, etc., and peaty button-grass plains with various Cyperaceae (*Mesomelaena*) and Restionaceae dominant. The forest occurs on soils of a higher mineral status and better drainage, while the button-grass community develops on wet, acid soil of very poor mineral status. Where these communities have remained in their virgin state, the rabbit has not penetrated.

Agricultural development of the button-grass community has proved impossible up to the present. Numerous attempts have been made to clear the rain forest for agricultural and pastoral development. In regions of high rainfall (more than 60 in.) and above elevations of 1,500 ft., such attempts have usually failed. The cleared land is now a wilderness covered with dead logs, bracken, and the more resistant undershrubs of the rain forest (for example, *Drimys*, *Leptospermum*, *Cassinia*). In the north-west and north-east dense populations of rabbits exist on such land.

In less than 150 years the rabbit has, thus, colonized a wide variety of habitats in Tasmania. During the summer of 1952-53, an attempt was made to determine if any genetical differentiation had occurred in response to the colonization of the different habitats. Several conspicuous colour variations occur in the rabbit. Counts of the frequency of these variations were made on living populations. In order to avoid bias owing to the different degrees of conspicuousness, the technique adopted was to walk slowly around an area, counting the rabbits as they bolted for cover. In good rabbit country a twenty-minute circuit will result in a count of between 100-200 rabbits. Usually two independent observers made a count on opposite sides of the road. The two counts agreed very well and have been grouped in the data. The majority of counts have been made along transects approximately perpendicular (running north-south) to the northern coast line. The transects start in rich farmlands on the coast and end 15-30 miles inland at altitudes of 1,500-3,000 ft. beyond which the rabbit has scarcely penetrated.

During the survey, nearly 10,000 rabbits were counted. Among the conspicuous colour variations noted are: (1) black, (2) 'blue', (3) yellow, (4) dutch, (5) irregular piebald, and (6) white. Of these, only the black and blue reach frequencies of more than 1 per cent. Among the 10,000 rabbits counted, 10 were dutch (8 agouti, 2 black), 3 yellow, 1 irregular piebald and 2 white. In addition to these major colour variants there are a number of minor variants only visible on trapped animals. They include white spots or stripes on nose and forehead with or without

white forepaws. Many of the blacks have a denser or lighter sprinkling with white hairs, and some of them have extensive dorsal areas of chocolate-brown fur. No accurate data exist on the frequencies of these minor variations.

Fig. 1 gives data on the frequency of blacks obtained on three of the transects. The most easterly transect (Great Lake-Deloraine) is about thirty-five miles east of the Nietta transect with the Hampshire transect another 15-20 miles farther west. It will be seen that the blacks increase in frequency to a maximum of 20-35 per cent of the total population in regions of high rainfall at elevations of more than 1,500 ft. Below this region the frequency of blacks falls off until at the coast it is less than 1 or 2 per cent. This clinal pattern is apparent over a region of approximately seventy miles along the north-west coast from Deloraine to Preolenna. There is some evidence that the clines are steepest in the middle of this range, the maximum black frequency decreasing both to the east and west of the central Nietta-Moina region. The same pattern exists on the north-east mountains although here only a single transect has been made. Over the rest of the island isolated counts are available. They show that the frequency of blacks is low (< 2 per cent) in the midland savannah country. The frequency rises to about 10 per cent in the open *Eucalyptus gigantea* forests on the central plateau around Great Lake. Frequencies higher than 20 per cent are always associated with cleared rain forest or mixed eucalypt-rain forest

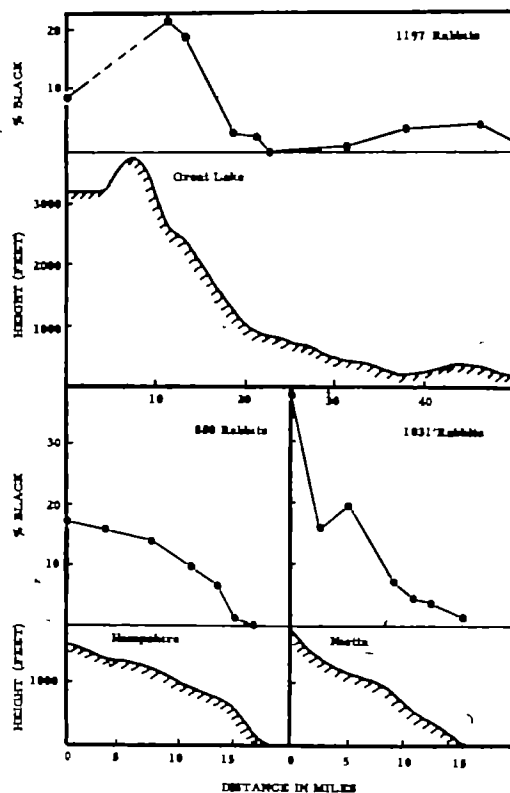


Fig. 1. Diagram of three transects running approximately south-north. Each transect ends near the coast of Bass Strait. An altitude section (vertical magnification approximately $\times 250$) is given immediately below the graphs showing frequency of black rabbits. Total rabbits counted is given for each transect. Minimum number of rabbits used in estimating frequency at any one point is 48; maximum 199; mean 123.

with a rainfall of more than 50 in. These relationships are best shown in Fig. 1, the frequency of blacks rising to a maximum in the partially cleared rain forest of the wet escarpment, and decreasing both on the central plateau and on the coastal plain where the vegetation, because of the lower rainfall, is open eucalypt forest. No attempts to estimate accurately the density of the rabbit populations were made. But there appears to be no correlation of the frequency of blacks with density or total numbers. A dense population can show a high or a low frequency of blacks, depending on the ecology of the site.

It is possible that the blue type shows a somewhat similar pattern of distribution; but accurate scoring of this type would involve large-scale trapping. The maximum frequencies are, however, considerably lower than those of the black.

The pronounced ecological correlation shows that the cline in the distribution of the blacks has been built up under the action of natural selection. The wetter regions, usually at altitudes of 1,500–2,500 ft., in some way favour the black. The situation in many respects parallels the distribution of the black hamster (*Cricetus cricetus*) in the southern U.S.S.R. Gershenson⁵ has shown that the black hamster may reach frequencies of more than 75 per cent in the humid forest-steppe region of its range. In the dry forest-steppe or mountain forest the frequency of black falls to zero. Guiler⁶ has also recently shown that the distribution of the black and grey phases of the Tasmanian brush possum (*Trichomys vulpecula*) shows a pronounced ecological correlation, the black phase again being correlated with heavy rain forest country (cf. Pearson⁴). In all three cases it is impossible at present to specify the advantages conferred by the black genotype in the wetter regions. It is possible that temperature may also be effective in selection. The rain forest localities probably show much less extreme temperature variations than either the alpine eucalypt or the savannah eucalypt forests.

Nothing is known of the genetics of the Tasmanian black rabbit. A few mixed litters of agouti and black and agouti and blue have been dug out. Gershenson⁵ has shown that the black type of hamster is caused by a single dominant gene which he thinks may be homologous to the extension black, *E^D*, of Punnett (see Castle⁷) in the rabbit and black rat. If the black in the Tasmanian populations is caused by this gene, steels (heterozygotes *E^DE*), in the presumably random mating population, should be commoner than the homozygous blacks (*E^DE^D*). The genetical constitution of the 'blues' in Tasmania is also unknown. They vary considerably in colour. It is unlikely that they could represent the heterozygous steels since their frequency is much lower than that of the black. It is possible that there has been a selective shift of dominance so that *E^D* has become completely dominant over *E*. But it appears more likely that we are dealing with the recessive black (*aa*). Breeding experiments are planned to determine the genetics of these colour types.

It is perhaps significant that the maximum frequency of black observed is 37 per cent. It is more usually 25–30 per cent along the border of the rabbit-free zone in the north-west. If black is recessive, this lower frequency would give the maximum frequency of heterozygotes in a random mating population. It is thus possible to envisage a selection system based on a heterosis effect in the humid rain

forest region, selection tending to equalize the allelic frequencies in this region. The black, to human eyes, is much the more conspicuous animal, particularly in the open savannah pastoral districts. Calaby⁸ has shown that bird predators may be responsible for the death of 4 per cent of kittens in the Murray Valley region of Australia. The birds may thus exert a counter-selection on black in the open country. Removal or lessening of this selection by increased cover may be one of the factors contributing to the establishment of the cline. Thus, the system of selection in the Tasmanian rabbits may show interesting analogies to that suggested by Ford⁹ to explain the origin of industrial melanism in several species of moths. In the moths a heterosis effect is absent, so that when selection against the dominant black mutants is relaxed, the frequency of the black allele rapidly approaches unity.

As regards the time taken to establish the clines, and whether a true equilibrium has been reached, little is definitely known. A maximum time for establishment is certainly less than fifty years. The Parrawe region near Waratah, where blacks reach a frequency of 25–30 per cent, was cleared between 1915 and 1925. Rabbits, according to local report, were absent in the primeval forest. Blacks have been present in the north-east mountains for more than forty years. It thus appears probable that a cline may be established in so short a time as twenty years. If this is the case, it is also probable that equilibrium has been reached. Southern¹⁰ has shown that migration distances are remarkably small for the rabbit in English warrens. If this is so under Tasmanian conditions, it would appear that the cline is a true selection cline and not due to a balance of selection and long-distance migration.

During the survey occasional evidence of myxomatosis was seen. The incidence of the disease in Tasmania since its illegal introduction in the late summer of 1951–52 has been very local. Of the three clines illustrated, the Great Lake-Deloraine cline had been slightly affected around Deloraine (between 20–30 miles). Dense rabbit populations still exist here and no difficulty was experienced in obtaining counts of 100–200 rabbits. It will be interesting to attempt to follow the changes in population density and genetic constitution if sudden fluctuations in density of the rabbit population occur. There is no evidence that any of the mutations studied in this survey confer any increased resistance or susceptibility to attack by the virus. However, the existence of mutants affecting coat colour at possibly more than five loci shows that the Tasmanian rabbit populations may possess an amount of genetic variability affecting other characteristics sufficient to allow them to adapt themselves to myxomatosis almost as quickly as the virus is evolving strains of less virulence¹¹.

I wish to thank Mr. W. D. Jackson and Mr. R. H. Cruickshank for much assistance during the field survey. [March 22.]

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Crystalline Material with Xanthine Oxidase Activity

In the course of investigations into the preparation, purification and chemistry of xanthine oxidase from cow's milk, as part of a larger programme of biological and chemical research into functional and structural cellular constituents, we obtained a crystalline material with pronounced enzyme activity.

It was produced by the slow addition, below 0° C., of ethanol (final concentration, 2-7 per cent) to an aqueous concentrate, referred to as 'starting concentrate' (salt content: *M*/100 phosphate buffer, pH 6.2), discarding the initial precipitates. The preparation of these fractions from buttermilk whey followed published methods^{1,2}, with certain modifications. Under the microscope, small needles, often bunched together in rosettes (Fig. 1), are recognizable. The values in Table 1 give an idea of the properties of two batches, A and B, of the crystalline materials as compared with the corresponding 'starting concentrates' and the mother liquors of crystallization.

It can be seen that although considerable enzyme activity (columns *e* and *f*) is retained by the mother liquors of the crystals, the latter show an improved 'protein/flavin' ratio (column *d*). On the basis of the calculation given in footnote (*f*), the Q_{O_2} of our best preparation, namely, crystalline material B, was 1,580 at 23° C., as compared with Morell's³ value of 694 at 19° C. It is interesting to mention here that when some of the fractions were tested against methylene blue, the rates of decoloration with hypoxanthine and xanthine as substrates in equal concentrations were the same (Q_{MB} c. 1,400; Corran *et al.*⁴ reported Q_{MB} 2,420); with acetaldehyde as substrate we found Q_{MB} c. 4,200 (Corran *et al.*⁴ give 3,500).

With regard to the composition of enzyme preparations, Philpot⁵ has distinguished in the concentrate of Corran *et al.*, just mentioned, three components, called γ , δ (main fraction) and ϵ , when submitting it to examination in the ultracentrifuge. Sedimentation experiments with our materials indicated that ϵ was barely detectable in all our runs, while γ was present in the starting concentrate A but was reduced in

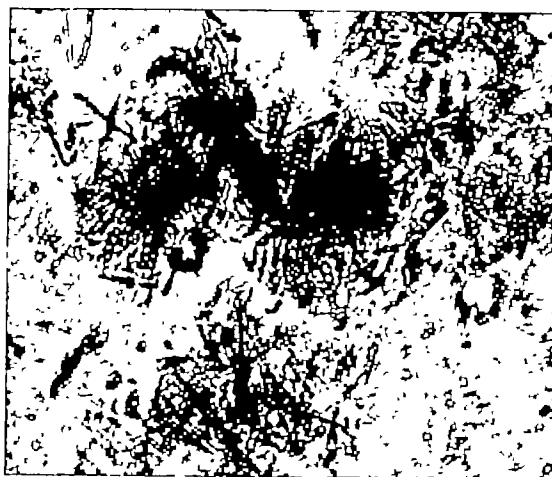


Fig. 1. Crystalline material A. ($\times 375$)

the crystalline material A and B to negligible amounts (Figs. 2 and 3). This was reflected in a fall in the corresponding 'protein/flavin' ratios (Table 1, column *d*). The colour was associated with the main fractions in each case. Preliminary molecular weight calculations based on such ultracentrifuge results indicated a molecular weight of about 200,000 for our main fraction. Electrophoresis experiments, so far carried out with 'starting concentrates' only (by Mr. D. W. F. James), showed on the whole one peak.

In accord with Green and Beinart⁶, molybdenum was found in all fractions; while crystalline material B came up to c. 0.03 per cent⁶, all other fractions contained rather less, namely, c. 0.02 per cent. FAD estimations carried out fluorimetrically⁷ infer an FAD/Mo ratio of approximately the published order^{8,11}. Richert¹² has recently reported the occurrence of iron in his milk xanthine oxidase preparations. While we found iron¹³, we are not yet certain whether this metal forms an integral part of the active lacto-xanthine oxidase molecule.

It is more than likely that even our best crystalline material obtained to date represents a mixture of active xanthine oxidase and perhaps slightly denatured enzyme of the same molecular weight; the difference between crystals A and B can be clearly

discerned in Table 1; the ratio $\frac{\text{activity (units/L)}}{E(450 \text{ m}\mu)}$

Table 1

<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>
Material	Batch	Dry weight (gm.)	Ratio: Protein/Flavin*	Ratio: Activity (units/L)/ <i>E</i> (450 m μ)	Ratio: Activity (units/L)/ <i>E</i> (290 m μ)
'Starting concentrate'	A	0.32	7.4	39	5.3
	B	1.93	8.5	62	7.3
Crystalline material	A	0.13	5.3	32	6.1
	B	0.35	5.1	63	10.4
Mother liquors	A	0.13	7.5	34	4.4
	B	0.48	12.4	57	4.6

a, 'Starting concentrate' as in text; crystalline material centrifuged, washed and redissolved; mother liquor without washings.

c, Calc. from *E*(290 m μ) with *E*(1%, 1 cm) = 11 (value based on Cl₂OCC₂H method (ref. 3) and Kjeldahl-nitrogen).

d, Ratio: $\frac{E(290 \text{ m}\mu)}{E(450 \text{ m}\mu)}$; pH 7.2.

e, Spectrophotometric assay method (refs. 4 and 5), with xanthine, pH 8.2, 23° C. Units = $[(\Delta E(1 \text{ cm}, 295 \text{ m}\mu)/\text{min}) \times \text{overall enzyme dilution} \times \text{volume of sample (in litres)}]$.

f, This is related to conventional Q_{O_2} = above ratio $\times 152$ [taking *E*(1%, 1 cm) = 11 and ΔE (oxid. 1 μ gm. xanthine/ml.) = 0.064] (see ref. 5).

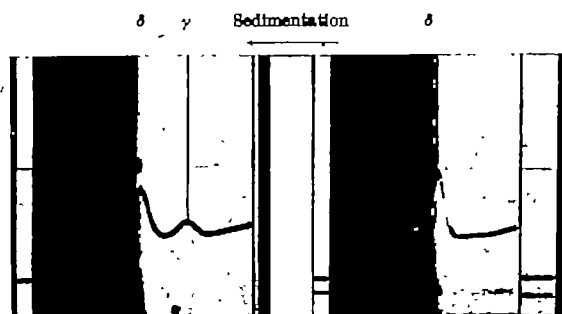


Fig. 2

Fig. 3

Sedimentation diagram using a 3-cm. column of liquid, the solvent being phosphate buffer of pH 6.2; (2) original concentrate A; (3) crystalline material A.

is regarded as being largely dependent on the relative amounts of active and inactive enzyme in the sample (see also ref. 5). So far we have not been successful in separating the functionally active portion from the closely related inactive one, as no operations with the crystalline or other material in our hands have yet brought about an improvement in the above ratio. The nature of the difference between active and inactive enzyme, as well as their chemistry, will form the subject of further studies. Details of our findings, reported briefly above, will be published elsewhere.

We are grateful to Prof. A. Haddow for his support, encouragement and continued interest. We wish to thank Prof. H. D. Kay and Miss H. Chapman, of the National Institute for Research in Dairying, for their assistance in supplying us with buttermilk, Dr. M. Dixon and Dr. H. M. Kalekar for their helpful criticism, and Dr. P. M. Cowan and Dr. W. E. Seeds for crystallographic advice. We acknowledge technical assistance by Mrs. K. Tussler and Mr. T. Stebbings. This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

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Stereochemistry of Certain Analgesics

We are investigating the configurational relationships existing among a group of optically active analgesics all of which possess one asymmetric centre. In 'Methadone' and related compounds it has been shown¹⁻³ that almost the whole of the analgesic activity resides in one of the isomers.

We have established that the analgesically active isomers '(-)-methadone' ((-)-6-dimethylamino-4:4-diphenylheptan-3-one), (-)-ethyl-1:1-diphenyl-3-dimethylaminobutyl sulphone, and (+)-3-dimethylamino-1:1-(2'-thienyl)-but-1-ene, possess identical configurations which are related to D-(-)-alanine. These relationships were established in the following way. The hydrolysis of (-)-ethyl-1:1-diphenyl-3-dimethylaminobutyl sulphone gives (-)-3-dimethylamino-1:1-diphenylbutan-1-ol⁴. This alcohol, after dehydration followed by reduction, gave (+)-3-dimethylamino-1:1-diphenylbutane, which was also obtained from (-)-4-dimethylamino-2:2-diphenylpentane nitrile, the precursor of (-)-methadone. L-Ethyl-3-dimethylaminobutyrate, derived from phthaloyl-L-alanine via an Arndt-Eistert reaction followed by reductive methylation, was treated with phenyl magnesium bromide to yield (+)-3-dimethylamino-1:1-diphenylbutan-1-ol. Reaction of this same ester with thienyl lithium gave (-)-3-dimethylamino-1:1-(2'-thienyl)-butan-1-ol, which gave (-)-3-dimethylamino-1:1-(2'-thienyl)-but-1-ene on dehydration.

In a recent communication, Bick⁵ has advanced evidence from which he concludes that morphine is configurationally related to L-(+)-alanine. His argument relates the two substances via apomorphine and laudanone and depends on the validity of a method of assigning configuration first employed by Leithe^{6,7}. Leithe maintained that the specific rotation of bases possessing analogous asymmetric centres and of like configuration are displaced in the same direction when examined in a series of solvents of increasing polarity.

Because the validity of Leithe's method has not been rigidly established, we have determined the specific rotations, in a series of solvents, of the compounds shown in Table 1. The configurations of these compounds are identical and have been established as described above. It is evident that in this series no relationship exists between configuration and direction of specific rotational change brought about by an increase in the polarity of the solvent.

We are therefore of the opinion that the method used by Bick to establish the relationship of morphine and apomorphine to the L-amino-acids is of doubtful value. Furthermore, we consider that the configurational assignments given by Leithe to alkaloids of the laudanone and berberine type are not conclusive.

The identical configurations of the analgesically active isomers reported in this communication; the antagonistic action exhibited by N-allylnormorphine ('Nalorphine') towards morphine and many of the synthetic analgesics; the antagonistic action towards morphine shown by (-)-N-allyl-3-hydroxymorphinan but not by the corresponding (+) isomer⁸; the identical configurations of (-)-N-allyl-3-hydroxymorphinan and (-)-3-hydroxy-N-methyl-morphinan⁹ (the isomer which is analgesically active whereas the (+)-isomer is inactive) give further support to the statement¹⁰ made some time ago by one of us (A. H. B.) that "before analgesic action can be mediated directly or indirectly, it is possible that the stereochemical

Table 1

	[α] _D ²⁰			
Me.CH(NMe ₂). CH ₂ .CPh ₂ .R	Base in cyclo- hexane	Base in benzene	Base in ethanol	Hydro- chloride in water
R = —CO ₂ H†	-24.4 (0-1.2)	-24.0 (0-1.3)	-23.0 (0-1.5)	-125 (ref. 11) (0-1.5)
R = —SO ₂ H†	—	+12.0 (In acetone (ref. 12) 0-2.0)	0 (ref. 12) (0-2.0)	-21.6 (ref. 12) (0-5.0)
R = —ON	-65.1 (0-0.9)	-50.5 (0-0.8)	-50.9 (0-0.8)	+6.0 (ref. 11) (0-5.0)
R = —H	-66.2 (0-4.8)	-50.3 (0-4.7)	+12.0 (0-3.4)	+52.7 (0-1.0)
R = —CO ₂ Bt†	-85.5 (0-2.0)	-73.8 (0-1.8)	-50.0 (0-1.8)	-37.3 (0-1.0)
R = —OH	+26.8 (0-0.8)	+22.6 (0-1.9)	-27.2 (0-0.8)	-45.1 (0-1.0)
Me.CH(NMe ₂). OH : CPh ₂	+123 (0-1.0)	+123 (0-1.0)	+170 (0-1.0)	+212 (0-0.9)

The effect of concentration upon the specific rotation is not significant in comparison with the effect of the solvent.

configuration of the drug must be complementary to that of a certain tissue surface or enzyme system". The presence of specific receptor sites for analgesic action is now a probability rather than a possibility.

A detailed account of the investigation of certain structural aspects of analgesics will be published elsewhere.

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Influence of Vitamin C on the Utilization of Sulphate labelled with Sulphur-35 in the Synthesis of Chondroitin Sulphate of the Costal Cartilage of the Guinea Pig

It has been reported that sulphate when administered to the rat is retained by cartilage, bone and bone marrow¹, and it is now further established that the sulphate is mainly incorporated into the chondroitin sulphate of the cartilage²⁻⁴. Since the utilization of the sulphate administered in the formation of chondroitin sulphate lends itself to quantitative determinations, this was used by us for studying the influence of vitamin C on the formation of this sulphuric ester in the costal cartilage of the guinea

pig. The evidence so far obtained by employing the histological techniques is not conclusive. Thus, Højer⁵, who was the first to observe the atrophy of collagen in the cartilage in scurvy, was not able to find any difference from the normal in regard to chondroitin sulphate by staining the sections with methylene blue. Contrary to the above observation, Meyer⁶, using basic metachromatic dyes, did not find any chondroitin sulphate in the cartilage of scorbutic guinea pigs.

Guinea pigs, eight weeks old and weighing 246-304 gm., were used in these studies. They were given large quantities of green leafy material for one week before the experiment and the scorbutic diet⁷ for the whole of the experiment. In addition, each guinea pig received 1 ml. of cod liver oil twice a week. Fresh tap water was also given daily. They were weighed once in four days. Twenty-six guinea pigs, consisting of equal numbers of males and females, were maintained on the scorbutic diet for nineteen days, and the typical symptoms of scurvy such as cessation of food intake, loss in weight and the tenderness of the joints were noticed. During the third week, three males and three females died. Twenty-six guinea pigs, consisting of equal numbers of males and females, received, in addition to the above scorbutic diet, 4 mgm. L-ascorbic acid *per os* each day. One guinea pig in the male group was found to be sick on the second day of the experiment and was discarded. The rest were healthy throughout the experimental period and steadily gained in weight.

On the nineteenth day of the experiment, the guinea pigs, both deficient and normal, were given intraperitoneally 0.02 mc. sodium sulphate-35 in dilute aqueous solution per 100 gm. body-weight. After the administration of the sulphate, they were maintained for 48 hr. under the dietary conditions described above. At the end of the period they were killed, and the costal cartilage was removed. The chondroitin sulphate from the cartilage was prepared

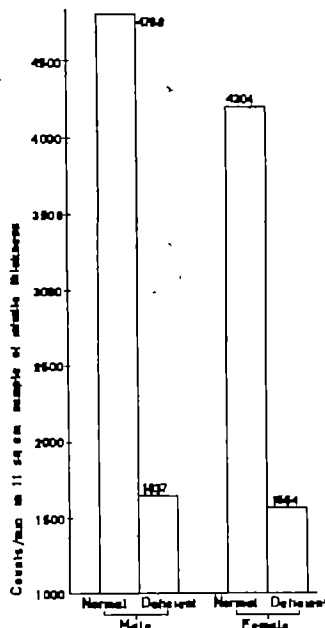


Fig. 1. Radioactivity of barium sulphate obtained from chondroitin sulphuric acid, prepared from the costal cartilage of normal and deficient guinea pigs. Normal—basal diet + 4 mgm. vitamin C/day. Deficient—basal diet only

according to the method of Jorpes⁶ as modified by Strandberg⁷ and by Boström⁸.

80 mgm. of chondroitin sulphate was hydrolysed with 5 ml. of 6 *N* hydrochloric acid in a steam-bath for 4 hr. The sulphate was precipitated as barium sulphate and collected in a tared goodish crucible, ignited and weighed. 20 mgm. of barium sulphate was suspended in 50 per cent alcohol and collected on a filter paper on a perforated aluminium disk. The precipitate was washed with absolute alcohol and ether, and radioactivity was measured in a Geiger-Müller counter with a 2.1-mgm. per sq. cm. mica end window. After the counts were taken, the samples were dried at 105° C. and the weights were checked.

The results in Fig. 1 show that the sulphate administered is incorporated into the chondroitin sulphate of the costal cartilage. The utilization of the sulphate in the formation of chondroitin sulphate was not significantly affected by variations in sex. But, however, there is a significant difference between normal and deficient guinea pigs in their utilization of the administered sulphate in the formation of chondroitin sulphate. The average incorporation in the deficient animal was about one-third that of the normal. The esterification of the sulphate group appears to be a very sensitive indicator for the metabolic disturbances in the cartilage in scurvy.

We are indebted to Prof. Erik Jorpes for facilities and for his interest during the course of this investigation, and also to Prof. Håkan Rydin, who offered us facilities for conducting the animal experiments in the State Pharmaceutical Laboratory.

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Diffusion of Alkaline Phosphatase to Characteristic Intracytoplasmic Sites of Activity

WHILE using superimposed frozen-dried sections of rat kidney for the study of diffusion phenomena¹ in the Gomori²-Takamatsu³ technique for alkaline phosphatase, it was observed that faint staining of the brush border regions in the underlying inactive section in very occasional tubules. This result was obtained after moderately prolonged incubation, even when inactivation of the underlying section was effected by heat. The appearances suggested that the enzyme itself, enzyme activator or phosphate ion was diffusing into the underlying section, and prompted further experiments to demonstrate enzyme diffusion to characteristic positions in the cell⁴.

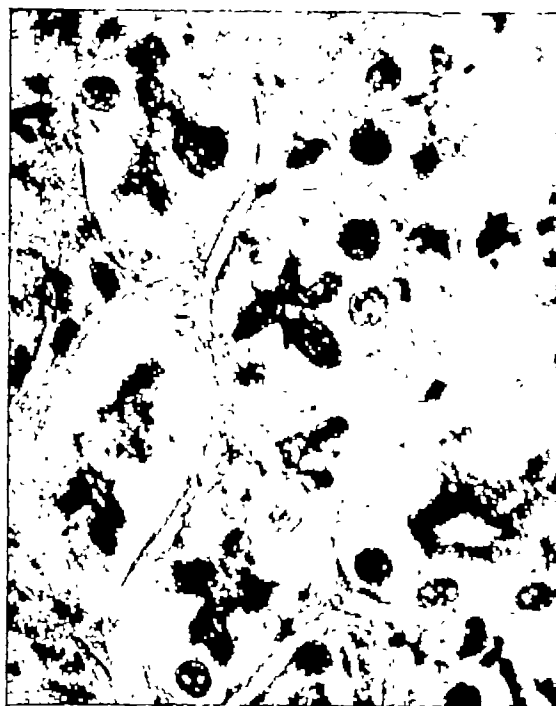


Fig. 1. Frozen-dried section of rat kidney heated at 95° C. for one minute, incubated at 37° C. in kidney mash suspension for one hour, washed in distilled water and incubated in glycerophosphate medium for four hours.

Frozen-dried 5- μ sections of rat kidney were deparaffinized in xylene, immersed in absolute alcohol for three minutes and passed through 50 per cent alcohol to water. The slides were then immersed in distilled water at 95° C. for one minute, which was shown in the control sections to inactivate the enzyme completely. They were next incubated at 37° C. in a solution containing 0.4 per cent sodium veronal and 0.4 per cent calcium nitrate to which was added a fine mash of fresh rat kidney. This solution had a pH (glass electrode measurements) of 8.7 before and 8.5 after one hour's incubation. After brief washing in distilled water the slides were incubated in the usual glycerophosphate medium, and sites of activity demonstrated by final precipitation of cobalt sulphide. After treatment of the inactivated section for one hour in the kidney mash suspension and subsequent incubation with substrate for four hours, staining was observable in the brush border regions of the tubules and in most nuclei throughout the kidney (Fig. 1). Shorter times of incubation in the two media produced similar but less intense results. Enzyme transfer could similarly be effected to heat-inactivated frozen-dried sections of rat duodenum.

Sections were also inactivated with 0.25 per cent nitric acid, 0.1 *N* hydrochloric acid, 10 per cent acetic acid and saturated mercuric chloride solutions. Substantially similar results were obtained after incubation with the mash suspension, although the nuclear appearances varied with the method of inactivation. With mercury-inactivated sections, treatment with a filtrate from a mash suspension previously heated to 95° C. for one minute resulted in reappearance of enzyme activity in characteristic sites. This filtrate had no effect in restoring enzyme activity in heat-inactivated sections.

Similar results were obtained with a mash suspension in distilled water with sections inactivated by mercuric chloride; but the nuclear staining was much less intense than in sections treated with the mash suspension in a sodium veronal-calcium nitrate solution. Mash suspended in distilled water had only a slight effect on sections inactivated with 0.25 per cent nitric acid, brush borders and very occasional nuclei being just visible. The fact that heated homogenate will not reactivate heated sections excludes the possibility that the diffusing substance is phosphatase activator (unless the latter is heat labile).

These findings point conclusively to the diffusion of alkaline phosphatase to normal as well as to other sites in the cell. Taken in conjunction with those of Gomori¹ and Novikoff², they suggest that something in addition to the enzyme and not calcium ions or sodium veronal is necessary to effect such transfer. There is some indication, however, that these latter substances may facilitate enzyme diffusion or its attachment in the cell. Such findings do not detract from the usefulness of the method provided that properly designed controls are used in any particular study.

The demonstration of diffusion of alkaline phosphatase and its attachment to other, as well as to characteristic, sites in the cell suggests that erroneous conclusions may be drawn from analysis of its activity in homogenate fractions. The use of histochemical controls thus seems to be essential in such studies.

I wish to express my gratitude to Prof. J. F. Danielli for his guidance in this and other studies on alkaline phosphatase.

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A Quantitative Method for Enzyme Cytochemistry applied to Alkaline Phosphatase

In the Gomori-Takamatsu technique for localizing alkaline phosphatase, tissue sections are incubated in a solution containing a phosphate ester and calcium ions. The phosphate ions liberated as a result of enzyme activity are precipitated in the section as calcium phosphate, which is made visible by converting it to cobalt sulphide. The cobalt sulphide is dark brown and gives only a rough indication of the degree of enzyme activity. A quantitative method¹ has recently been developed for measuring the mass of substances (other than water; that is, dry mass) in cells. It has been shown that the dry mass can be determined from measurements of optical path difference which can be made with an interferometer microscope. This note describes measurements made with this technique of the amounts of calcium phosphate deposited as a result of phosphatase activity. We have found that the interferometer-microscope method can be used to study the magnitude of possible artefacts due to diffusion of

enzyme and diffusion of the calcium phosphate. We have also found that interferometry provides a most promising approach to the quantitative determination of enzyme activity at sites in cells.

Previous observations by Moe² with the Gomori-Takamatsu technique indicated that after initial precipitation large-scale diffusion of calcium phosphate may occur from the sites of precipitation to other sites in the section. For example, after about one minute's incubation a heavy deposit of calcium phosphate was found in the intestinal brush border. But after an hour's incubation the brush border appeared to contain no calcium phosphate, and other previously negative sites now became positive. Ruyter³ showed that these results were open to another interpretation, namely, that the calcium phosphate precipitated in brush borders changes its reactivity and can no longer react with the Gomori-Takamatsu reagents. Observations⁴ by phase-contrast microscopy confirmed Ruyter's observations that the processes discovered by Moe do not, in fact, involve a diffusion but rather a change in the physical state of the calcium phosphate. However, unlike the interferometer microscope, the phase-contrast microscope gives only a rough indication of the amount of calcium phosphate.

In our experiments, frozen-dried 4- μ sections of either rat kidney or duodenum, fixed in absolute alcohol for three minutes, were mounted in water in a chamber for continuous observation and measurement with a Dyson⁵ interferometer microscope, made by Cooke, Troughton and Simms, Ltd., objective numerical aperture 1.3. The optical path difference of a site in the brush border was first determined and the section then perfused with a solution of pH 9.3 containing 0.4 per cent sodium glycerophosphate, 0.4 per cent sodium veronal, 0.2 per cent calcium nitrate and 0.04 per cent magnesium chloride. The increase in optical path difference due to deposition of calcium phosphate was recorded as a function of time. Fig. 1 shows results obtained with the brush border of the rat kidney. The rate of deposition is approximately constant for about twenty-five minutes and then slowly diminishes with time. The calcium phosphate was removed from the section with buffered distilled water (pH 7.0) and the section again perfused with the same substrate solution at pH 9.3. Measurements at the same site in the brush border showed the same rate of increase of calcium phosphate as found originally (Fig. 1). We have repeated these experiments six times on a single section (total incubation time, three hours) and have

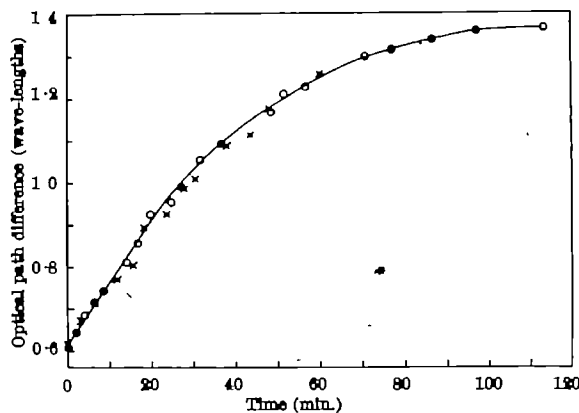


Fig. 1. Increase in optical path difference (proportional to mass of calcium phosphate per unit area) in kidney brush border during first incubation (O) and second incubation (x).

found that the rate of deposition of calcium phosphate is unaltered within the limits of experimental error. These results indicate that under these conditions the amount of enzyme activity in the brush border of rat kidney remains constant.

In order to find out if calcium phosphate, once formed, can diffuse, the section containing calcium phosphate was immersed in the incubation solution without substrate. After twenty-four hours in this solution at pH 9.3 no change in optical path difference in the brush border, and hence no change in amount of calcium phosphate, could be detected. Therefore, under these conditions calcium phosphate apparently does not diffuse once it has been precipitated.

An important advantage of this technique is that the enzyme activity at one site in one cell can be measured repeatedly under various conditions and a check finally made to see if the enzyme activity under the initial conditions remains unchanged. The following factors which affect both the rate of liberation of phosphate ions and the rate of deposition of calcium phosphate are being investigated: pH; temperature; type and concentration of substrate; concentrations of calcium ions, buffers and activators. The rate of deposition of calcium phosphate during the linear phase, per unit dry mass of tissue, under certain defined conditions of pH, etc., may be used as a quantitative measure of enzyme activity. A full report of these investigations will be published elsewhere.

This technique can be used for the cytochemical study of any other enzymes which, as a result of their activity, produce a measurable change in optical path difference.

We wish to thank Prof. J. T. Randall for his encouragement and for providing facilities for this work, and Dr. L. G. Ball for his guidance in the freeze-drying of tissues. Part of the expense of this research has been defrayed by a grant from the Rockefeller Foundation.

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Chemical Composition of the Golgi Apparatus in the Exocrine and Endocrine Cells in the Pancreas of the Mouse

It has recently been shown that pancreas cells (exocrine and endocrine) contain a canal-like Golgi apparatus distinct from all other cell inclusions¹. Since then I have used various histochemical tests to determine the chemical composition of this canalicular structure.

It has often been suggested that the Golgi apparatus contains a lipid capable of reducing silver nitrate

and osmium tetroxide. In support of this view, I have found that when pancreatic tissue is treated first with lipoidal solvents (ether-alcohol, acetone) and then by Aoyama's silver method, there is a total failure to impregnate any inclusions. However, the apparatus remains uncoloured when Baker's² sudan-black method for lipids is used. The reason for this latter result appears to be that the lipid is 'masked' in some way, for it can be coloured with sudan black if the tissue is fixed in Aoyama's fluid, treated with 1½ per cent silver nitrate for 17 hr., washed and embedded in gelatin. In an attempt to determine whether this lipid contains a phospholipin, I used the acid hamatin test exactly as described by Baker³ and, in addition, after the previous use of silver nitrate as an 'unmasking agent'. The full results, in both cases, are as follows: Golgi apparatus = negative; mitochondria = positive; lipoidal bodies = negative; zymogen granules = positive; islet granules = positive.

At least two significant points have emerged from the use of the acid hamatin test. First, I have shown previously¹ that sudan black does not colour zymogen or islet granules (and only occasionally mitochondria) and yet all contain a phospholipin. Therefore a negative result with sudan black does not prove the absence of certain lipids (for example, phospholipins). Secondly, the results seem to disprove the main conclusion reached by Palade and Claude⁴ that the Golgi apparatus is an artefact produced by the action of classical fixatives (particularly Aoyama's fluid) on inclusions rich in phospholipins. My work indicates that: (1) the Golgi apparatus does not contain any phospholipins, and (2) inclusions containing phospholipins (mitochondria, zymogen granules and islet granules) are not distorted in any way by the action of Aoyama's fixative.

Attempts have been made to decide whether the Golgi apparatus contains a protein or a carbohydrate. Weigl⁵ managed to stain bleached Kopech preparations with resorcin-fuchsin, which usually stains proteinaceous connective tissue (see Baker³). However, when fresh resorcin-fuchsin, made up from Weigl's original formula, was used on bleached Aoyama preparations in pancreas cells, there was a total failure to colour the apparatus. Millon's test for protein also gave a negative result. Negative results were obtained for glycogen and mucin (Bauer-Feulgen test⁶) and mucopolysaccharides (Evan's blue method used in conjunction with freeze-drying⁷). Nevertheless, there is still reason for believing that the Golgi apparatus does contain a protein and/or carbohydrate, since it is preserved by freeze-drying⁸.

It has often been suggested that vitamin C may be associated with the Golgi apparatus (see Bourne⁹). Accordingly, Bourne's test⁹ for ascorbic acid was used. A negative result was obtained in the regions where both the Golgi canals and adjacent lipoidal bodies occur, namely, mainly in the zone basal to the zymogen granules. Thus it would appear that whereas the Golgi apparatus or lipoidal bodies may segregate vitamin C under certain conditions⁹, the vitamin does not constitute an essential or permanent part of either organelle. Similarly, it has been suggested that alkaline phosphatase might occur in the Golgi apparatus⁹. However, when Gomori's¹⁰ method was used on pancreas cells, I failed to detect alkaline phosphatase in the Golgi zone although a strong reaction was obtained in capillaries.

I am indebted to Dr. A. J. Marshall for his support in this work and would like to thank Prof. J. Rotblat,

Prof. C. Boswell, Dr. G. E. Francis, Miss M. Blundell and Miss M. Jeremy for help in various ways.

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² Baker, J. B., *Quart. J. Micro. Sci.*, 86, 1 (1944).

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Solubility of Oxygen in Water

THE rate at which self-purification can occur in waters polluted by oxidizable organic matter may depend largely on the rate at which oxygen from the air is dissolved by the water. In natural water the rate of solution is influenced by many variable factors; but Adeney and Becker¹ have stated that for constant conditions, and for a uniformly mixed body of water, it is proportional to the difference between the concentration of oxygen in solution and the saturation or equilibrium concentration. Unfortunately, the absolute saturation values are not known with great precision; indeed, some of the values published by several independent investigators differ by as much as 0.4 part of oxygen per million at temperatures in the range 0°–35° C. The most generally accepted values are, however, those quoted by the American Public Health Association in "Standard Methods for Examination of Water and Sewage"²; these are based on gasometric determinations by O. J. J. Fox³.

In an investigation to provide information about the effect of natural variable factors on surface aeration, we have made many measurements of rates of aeration of pure water, the concentration of dissolved oxygen being determined by the Winkler⁴ titration method using an amperometric end-point⁵ in the final titration of iodine. We have consistently found that over a range of temperature 0°–35° C. the Adeney and Becker law of aeration is not satisfied when rates of solution of atmospheric oxygen are evaluated from the difference between the accepted saturation values and the dissolved oxygen concentration of the solution determined by the Winkler method. This discrepancy arises because the accepted saturation values are higher than the values obtained when the concentration of oxygen in water in equilibrium with atmospheric oxygen is determined by the Winkler method. This is a matter of some importance since it is the Winkler method which is most commonly used for the determination of dissolved oxygen and hence of rates of solution both in the laboratory and in field investigations.

In our experiments, the concentration of oxygen in deionized distilled water was either reduced or increased to a value well below or above the saturation value at a given temperature; the water was then slowly stirred to bring it into equilibrium with an atmosphere of air which had been saturated with water vapour and from which carbon dioxide had been removed. Measurements of dissolved oxygen were made at intervals until several successive samples, taken over a period of days, gave a constant value when corrected for changes in atmospheric

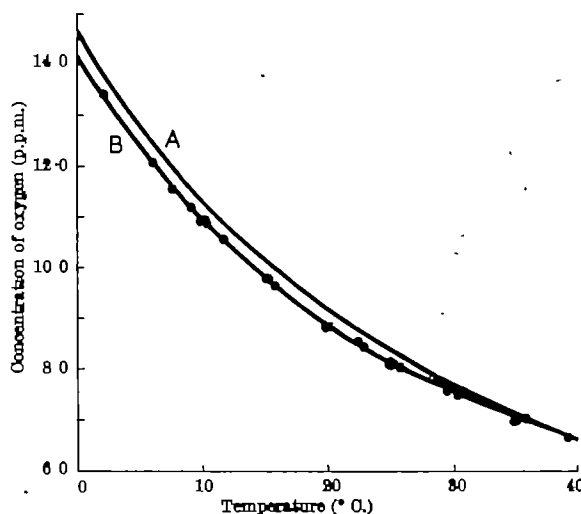


Fig. 1. Curve A, saturation values taken from "Standard Methods" calculated by Whipple and Whipple on measurements made by O. J. J. Fox (atmosphere assumed to contain 20.9 per cent oxygen); curve B, saturation values determined by the Winkler method.

pressure. This value was assumed to be the saturation concentration at the temperature of the experiment. The results obtained by this procedure are related by the empirical equation $C_s = 14.16 - 0.3943T + 0.007714T^2 - 0.0000646T^3$, where C_s equals saturation concentration in parts of oxygen per million and T equals temperature in degrees C. The standard error of the curve is 0.05 part of oxygen per million. A comparison between these values and those determined gasometrically by Fox are shown in Fig. 1. It is noteworthy that much better agreement with Adeney and Becker's law of aeration may be obtained with these saturation values than with the generally accepted ones. Moreover, for the purpose of determining rates of solution in natural waters, these saturation values are less 'artificial' than the accepted values in that they were obtained in waters in equilibrium with atmospheric oxygen rather than with pure oxygen in a sealed apparatus. It is of interest in this connexion that Holroyd and Parker⁶ in their work on the dynamics of aeration have reported that they were unable to approach the accepted saturation values, though they attributed this to a thermometric error.

The discrepancy between the saturation values we have obtained and the standard values has stimulated interest in the determination of absolute saturation values. A number of gasometric determinations of the saturation value of oxygen at 25° C. have been made in this laboratory, and the results so far obtained are in close agreement with the value calculated from the above equation at this temperature. These investigations are being continued, and a full account will be published elsewhere.

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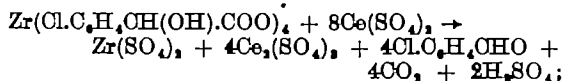
Volumetric Method for the Determination of Zirconium

KUMINS¹ observed that mandelic acid separates zirconium quantitatively from a large number of elements, and its use as a specific reagent for zirconium is being extended in analytical practice²⁻⁴, in preference to the time-honoured methods of affecting the separation as phosphate or basic selenite⁵. In a series of papers, Klingenberg and his colleagues^{6,7} have investigated the possibility of using α -hydroxy carboxylic acids as specific reagents for zirconium determinations and have shown that a direct weighing of *p*-chloro- and *p*-bromo-mandelates of zirconium is a satisfactory procedure for the gravimetric determination of the metal. The halo-derivatives of mandelic acid exert a large weighting effect on the zirconium ion and further, unlike the zirconium mandelate, these are not water-soluble. Hahn⁸ has further explored the use of *p*-bromo-mandelic acid for the determination of the zirconium-hafnium ratio by a computation from the combined weights of the *p*-bromo-mandelate of zirconium and hafnium and the weight of the oxides obtained therefrom by ignition. Jonckers⁹ has studied the reactivity of groups in relation to their application to inorganic analysis.

We have been engaged in a study of the cerimetric oxidation of organic acids and have found that mandelic acid can be quantitatively oxidized by ceric sulphate^{10,11}: the volume of ceric salt consumed can be used as a measure of the mandelic acid content. It was also noted that the same reaction can be extended to *p*-chloro- and *p*-bromo-mandelic acids.

In the present investigation we have explored the possibility of developing a volumetric method for the determination of zirconium by taking advantage of the above reaction.

Zirconium tetra *p*-chloro-mandelate was precipitated from a known volume of the zirconium solution by following the method of Klingenberg, filtered through a sintered-glass funnel of medium porosity, washed, dried and weighed. The halo-mandelate was dissolved from the crucible by a hot solution of ammonia, the solution acidified and boiled for fifteen minutes with a known excess of standard ceric sulphate solution. The excess was titrated back with standard ferrous sulphate solution using ferroin as internal indicator. The reaction may be represented as follows:



or 1 gm.mol. of zirconium tetra *p*-chloro-mandelate reacts with 8 gm.mol. of ceric sulphate. Similar reactions apply to the zirconium tetra-*p*-bromo-mandelate, and the same procedure was followed for precipitating, dissolving and titrating the zirconium salt.

In Table I are given typical figures obtained on 2 ml. each of a sulphuric acid solution of zirconium oxide.

It may be seen from the above that the cerimetric oxidation method is applicable to the volumetric determination of zirconium, and the results obtained are reproducible with a great degree of accuracy. The method is being extended to the determination of zirconium in ores and steels. It gives promise of application to even smaller quantities, and full details will be published elsewhere.

Table I

Method of determination	Wt. of zirconium oxide found (gm.)
(a) Gravimetric (phosphate method)	0.007633
(b) Gravimetric (from wt. of <i>p</i> -chloro-mandelate)	0.007590
(c) Volumetric (from vol. of ceric sulphate used for the chloro-mandelate)	0.007641
(d) Gravimetric (from wt. of the <i>p</i> -bromo-mandelate)	0.007592
(e) Volumetric (from vol. of ceric sulphate used for the bromo-mandelate)	0.007614

Our thanks are due to Dr. R. C. Shah, of the National Chemical Laboratory of India, Poona, who supplied the halo-mandelic acids, and to Sir K. S. Krishnan, director of the National Physical Laboratory of India, for his kind interest in the work and his permission to publish this communication.

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¹ Kumins, O. A., *Anal. Chem.*, **19**, 376 (1947).

² Gavioli, G., and Traldi, B., *Le Metallurgie*, **48**, 170 (1950).

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Structure of Pristimerin

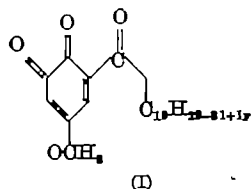
Bhatnagar and Divekar¹ described the isolation of an antibiotic, an orange-coloured pigment which they called 'pristimerin', from *Pristimeria indica* and *P. grahami* (Celastraceae). They found that this compound is particularly active against the *viridans* group of streptococci. We have been studying the constitution of this complex molecule.

Pristimerin crystallizes in orange needles of melting point 218–219° from petroleum ether–benzene. On the basis of analytical results and molecular weight (429) determined by X-rays (private communication from Prof. J. D. Bernal to Col. S. S. Bhatnagar), it has been assigned a molecular formula $\text{C}_{25}\text{H}_{32}\text{O}_4$. The physical and chemical properties and infra-red and ultra-violet spectroscopic evidence show it to be a β -quinone derivative. It contains one methoxy group and gives a negative Zerewitinoff test for active hydrogen. The latter observation finds confirmation in the infra-red absorption spectrum, in which the —OH band is absent. Reductively acetylated or methylated pristimerin (melting points 248° and 186° C. respectively) shows ultra-violet absorption suggestive of an acetoxyated or methoxyated benzene ring system, thus indicating that pristimerin may be a derivative of β -benzoquinone and not of naphthaquinone, nor of a quinone containing fused-ring systems of more than two aromatic rings.

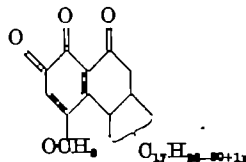
Methylated pristimerin contains three methoxy groups and one double bond, and forms 2,4-dinitrophenylhydrazone, showing that the fourth oxygen in

the molecule is ketonic in nature. Lithium aluminium hydride reduces the orange solution of pristimerin in ether to a colourless solution which on acidification and aeration becomes orange in colour. Furthermore, two compounds (melting points 165°C . (dec.) and 205°C . (dec.)) without the methoxy group originally present in the molecule are obtained. The physical and chemical properties of these show that they still have β -quinone structure and are keto-enol isomers. Ultra-violet absorption curves of these compounds show that the third $-\text{CO}-$ group, which is reduced to $-\text{CHOH}-$ by lithium aluminium hydride, is probably conjugated with the β -quinone system. The fact that pristimerin does not form derivatives with ketonic reagents or orthophenylene diamine and gives a positive test with boracetic anhydride and tin tetrachloride suggests that the third keto group is sterically hindered and is probably in the peri-position to the β -quinone grouping. The labile character³ of the $-\text{OMe}$ group towards lithium aluminium hydride, acids or alkalis indicates its presence in the quinone part of the molecule, probably in a grouping $\text{OMe}-\text{C}=\text{C}=\text{O}$. Thus the chemical and physical data so far obtained can well be interpreted by the following tentative partial structure (I).

Preliminary selenium dehydrogenation experiments indicate that the molecule may be a steroid or triterpenoid. In view of this and of the fact that triterpenes have been isolated from this species of the plant, the partial structure (I) may possibly be further elaborated to (II).



(I)



(II)

Celastrol⁴, a quinone isolated from *Celastrus scandens* L., was assigned a molecular formula $\text{C}_{18}\text{H}_{16}\text{O}_4$. It appeared more than a coincidence that the melting points of pristimerin and the methyl ether of celastrol are the same. Ultra-violet absorption curves of pristimerin and celastrol are very similar, and both the compounds were isolated from the same family of the plant; hence a mixed melting point of pristimerin with methyl celastrol was taken. No depression was observed, showing that pristimerin and methyl celastrol are probably identical.

A complete account of this investigation will be published elsewhere. We are grateful to Col. S. S. Bhatnagar for suggesting this work and supplying pristimerin, to Prof. J. D. Bernal for determining molecular weight by the X-ray method, to Prof. O. Givold for sending a sample of methyl celastrol, and to Dr. V. M. Thakore for his collaboration in the initial stages of this work. We thank Dr. Bholanath for the preliminary experiments on selenium dehydrogenation.

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Half-life of Curium-242

The most recently published value for the half-life of curium-242 is that of Hanna, Harvey and Moss¹, namely, 162.5 ± 2 days. This was determined by observing the proportions of americium-241 and curium-242 in samples of neutron-irradiated americium by pulse analysis methods over periods of up to one year.

The present measurements have been made by direct counting of α -particles from a source of pure curium which had been exhaustively purified from americium by ion-exchange methods. The α -counter used was of the low-geometry proportional type² designed for high precision and long-term stability³.

The curium source was deposited on a polished platinum disk. It was practically weightless, and gave initially about 2×10^7 α -disintegrations per minute. During a period of about seven months, fourteen measurements were made, each to a statistical accuracy of ± 0.1 per cent (that is, at least 10^4 counts were recorded).

It was necessary to correct for the growth of the long-lived α -active daughter, plutonium-238, and for this purpose the half-lives of curium-242 and plutonium-238 were taken as 162.5 days and 89 years respectively; but as these corrections amounted to less than one per cent of the counting-rate in every case, the final result is not critically dependent on these assumptions.

The corrected counting-rates were fitted by the least squares method to a linear relationship of the form:

$$\ln C_t = \ln C_0 - \lambda t,$$

where C_0 and C_t are the corrected counting-rates at time 0 and time t respectively, and λ is the decay constant of curium-242. The deviations of the experimental points from this straight line were quite random and showed no detectable trend with time, as would be expected if the sample contained any long-lived contaminant (for example, americium-241 of curium-243), or if the correction for plutonium-238 were inaccurate. The results were consistent with the existence of random effects producing a standard deviation of ± 0.1 per cent in addition to the standard deviation of ± 0.1 per cent due to counting statistics.

The slope of the least squares line gave a half-life value of 162.46 days with a standard deviation of ± 0.27 day.

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In connexion with the work described above, we have attempted to provide a check on the half-life of curium-242 by the entirely independent method of calorimetry.

A sample of approximately 2 μgm . of curium-242, slightly less pure than that used above, was kindly made available to us by Dr. J. Milsted. We have determined the total heat output of this sample at

intervals over a period of twelve months, using a specially designed twin microcalorimeter which gave a precision of measurement of approximately ± 1.5 microwatt (± 0.00086 cal./hr.). The small size of the sample and consequent very low heat outputs (400 μ W. at the beginning, falling to 100 μ W. at the end of the experimental period) seriously limit the precision attainable in the determination of the half-life; but the results appear to be sufficiently precise to confirm the value already published.

After correcting for the plutonium-238 daughter produced on decay, and for a small amount of a long-lived contaminant, we have computed the half-life from each pair of our results, using the formula:

$$\tau_{1/2} = \frac{0.693t}{2.303 (\log_{10} A_t - \log_{10} A_0)}$$

t being the time interval in days and A_t and A_0 the heat outputs corresponding to times t and zero respectively.

The mean value obtained is 163.0 days with a standard deviation of ± 1.8 days. A detailed account of this work is to be published elsewhere.

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Speed of Circulation in Droplets

THE initiation of circulation in the form of vortex rings in droplets in motion in another liquid has been shown to depend on such physical properties as the viscosity of both the liquid in the droplet and of the outer liquid, and also particularly on the character of the interface. An attempt is now being made to obtain the velocity of circulation inside such liquid droplets in relation to their speed of fall or rise under varying conditions.

In preliminary experiments, droplets of redistilled nitrobenzene containing aluminium particles were allowed to fall through a 0.5 per cent w/w solution of 'Cellofas B' in tap water (viscosity c. 12 centipoises) contained in a square cross-sectioned column of dimensions 80 in. $\times$ 2 in. $\times$ 2 in. Their fall was photographed using a 16-mm. ciné camera to give a magnification of 1/3, and the camera table was counterbalanced by a weight and pulley system so

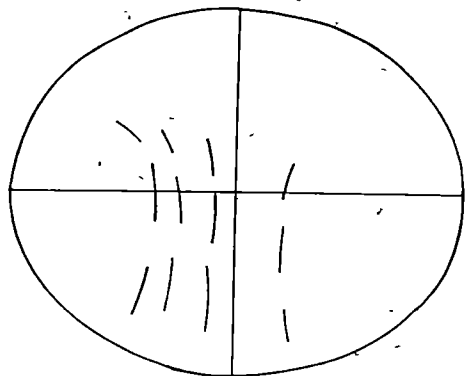


Fig. 1. The further the streaks from the centre of the droplet, the greater their elongation due to refractive distortion

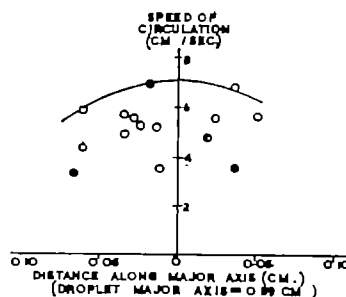


Fig. 2

that with judicious hand pressure the path of the droplet could be followed. High-powered side-lighting was used, and the amount of aluminium in the dispersed phase was such that, with a camera speed of 64 frames per sec., dark streaks were recorded on the film by reflexion from the individual particles. A series of frames showing the fall of a droplet were enlarged by projection and, with each image of the droplet occupying the same position on the screen, successive streaks made by the same particle were plotted to trace the streamlines of circulation (Fig. 1).

From the length of the streaks and the frame-speed of the camera, the velocities along each streamline were obtained. After allowing for refraction at the interface by geometrical construction, these velocities were plotted against the distance from the centre of the droplet to the intersection of the streamline and the major axis.

The envelope of these points represents the velocity distribution in the vertical plane through the centre of the drop perpendicular to the optical axis, and its peak gives the highest circulation velocity. (Points below this envelope represent motion in other vertical planes, Fig. 2.)

For a droplet of major and minor axes equal to 0.59 cm. and 0.47 cm. respectively, this velocity was found to be 7.3 cm./sec. compared with a fall velocity of 13.4 cm./sec. For a spherical droplet the maximum possible circulation velocity is equal to 1.5 times the velocity of fall, so that it can be inferred that the circulation in this particular droplet is about 30 per cent of its maximum possible value.

The velocity of circulation decreased during fall; but as no attempt was made to eliminate injection effects due to the nozzle, it is not yet clear whether this was due to a change in the interfacial properties or not.

During the analysis there is a difficulty in accurately measuring the velocities, especially of particles at 'apparent' distances from the centre greater than half the radius. The work is being continued using liquids of the same refractive index in order to obtain the circulation velocity distribution more accurately, particularly nearer the surface of the droplet. It may then be possible to show how the relative rate of circulation varies with the physical properties of the system, and hence throw more light on the phenomena influencing the initiation of circulation.

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Infra-Red Dichroism of Nylon and Polyethylene Terephthalate

In this laboratory we have been studying for some time the polarized infra-red spectra of single fibres and filaments. A 0.78 N.A. reflecting microscope of our own design, used with a Perkin-Elmer Model 12-C infra-red spectrometer in an arrangement similar to that of Blout, Bird and Grey¹, has allowed examination of specimens as narrow as 20 microns in width. Polarized radiation was obtained with a silver chloride sheet transmission polarizer. The very thin specimens required for the fundamental region of the spectrum were prepared by either longitudinally sectioning or mechanically flattening the single fibres.

A series of drawn specimens of nylon 66 and polyethylene terephthalate, kindly supplied by E. I. du Pont de Nemours and Co., Inc., have yielded results of particular interest. A summary of dichroism ratios observed for a number of absorption bands in specimens of different (nominal) draw ratio is given in Table 1. Each value represents the average of measurements made on 8-15 single filaments, and has been corrected for scattering losses, but not for the effect of beam convergence in the reflecting microscope. We have found that the latter correction is small, and does not alter the general results. It was also established that no appreciable double orientation was present in the specimens.

Table 1. DICHROISM RATIO ($\epsilon_{\parallel}/\epsilon_{\perp}$)

	cm. ⁻¹	Draw ratio					
		1	2.02	2.90	3.90	5.02	5.99
Nylon 66	3,810	0.98	1.85	1.25	0.98	0.79	0.84
	3,075	1.87	1.98	0.74	0.42	0.42	0.46
	2,930	0.92	1.23	1.20	0.96	0.90	0.99
	2,860	0.98	1.84	1.13	0.80	0.77	0.78
Polyethylene terephthalate	1,021	0.88	0.98	1.17	1.46	1.09	1.53
	975	0.43	1.61	2.04	3.43	3.92	8.03

It is seen that the four nylon absorption bands exhibit parallel dichroism at the lower draw ratios, and change over to perpendicular dichroism as the drawing proceeds. Hitherto, only perpendicular dichroism has been observed for these bands in highly oriented films^{1,2}. The 3,810 cm.⁻¹ N—H stretching vibration and the two methylene stretching motions at 2,930 and 2,860 cm.⁻¹ change dichroism in unison, as would be expected since the corresponding transition moments are all perpendicular to the chain axes. The 3,075 cm.⁻¹ band, the assignment of which is still in doubt, exhibits greater extremes in dichroism ratio, and changes from parallel to perpendicular character at an earlier stage. At draw ratios of 1 and 2 there is evidence that the extent of parallel dichroism for the 3,075 cm.⁻¹ band may be affected by the degree to which the filaments are flattened prior to infra-red examination⁴. This effect has not been observed for the other three bands of nylon 66.

We have observed that the change in dichroism character at about draw ratio 2.02 is quite general throughout the spectrum of polyethylene terephthalate. In addition to the 1,021 and 975 cm.⁻¹ bands, at least six other bands in the region 1,500-700 cm.⁻¹ reverse their initial dichroism as a result of drawing. The dichroism of the highly drawn filaments agrees in general with the results of Miller and Willis⁴.

In the nominally undrawn condition (draw ratio 1), dichroism was found to be present in the polyethylene terephthalate, and to a lesser extent in the nylon,

even though the undrawn filaments of both showed very low birefringence. The X-ray patterns of undrawn nylon indicated an unoriented, crystalline structure; on drawing, orientation was induced but with little change in crystallinity. The polyethylene terephthalate, initially amorphous, developed crystallinity on drawing, most markedly between draw ratios 2.99 and 3.99, where an inflexion in its birefringence curve appeared. In neither material, however, did X-ray patterns or birefringence measurements give evidence of a major reversal of chain orientation which the infra-red results alone might imply.

These results indicate that measurements of infra-red dichroism of fibres may reveal chain orientation which is not detected by the usual X-ray and optical techniques. Holmes *et al.*⁶ have reported that the amorphous regions in stretched polyethylene film are oriented at nearly right angles to the crystalline regions. It is possible that in poorly oriented fibre specimens the amorphous regions have a chain orientation quite different from that attained in the fully drawn, crystalline material, and that at the lower extensions the orientation of the amorphous regions largely determines the infra-red dichroism. Keller's recent suggestion⁷ of helical structures in synthetic polymers offers another very attractive explanation of some of these results, and is being investigated further.

RICHARD G. QUINN
RICHARD STEINLE

Textile Research Institute,
Princeton, New Jersey. Feb. 6.

¹ Blout, R. R., Bird, G. B., and Grey, D. S., *J. Opt. Soc. Amer.*, **40**, 806 (1950).

² Ambrose, H. J., Elliot, A., and Temple, R. B., *Proc. Roy. Soc. A*, **190**, 183 (1949).

³ Bamford, C. H., *et al.*, *Proc. Roy. Soc. B*, **141**, 49 (1953).

⁴ Caroli, G., and Dusenbury, J. H. (private communication; Textile Research Institute).

⁵ Miller, R. G. J., and Willis, H. A., *Trans. Farad. Soc.*, **49**, 433 (1953).

⁶ Holmes, D. B., *et al.*, **171**, 1104 (1953).

⁷ Keller, A., *J. Polymer Sci.*, **11**, 567 (1953).

Rotational Analysis of the Columbium Oxide Bands

In a previous communication¹, the rotational constants determined for the ground and excited states of the columbium oxide molecule have been reported as derived from the rotational analysis of the three bands λ 4,510 (1,0), λ 4,689 (0,0) and λ 4,915 (0,1). Due to an error, which has unfortunately crept in, in the calculation of the r_e values, it has since been found necessary to revise the analysis and to redetermine the constants. This work has been carried out. The two R and the two P branches and the K -numbering have been confirmed from the combination relationships. The revised rotational constants are:

$$\begin{array}{ll} B_0^* = 0.2447 \text{ cm.}^{-1} & B_1^* = 0.3776 \text{ cm.}^{-1} \\ B_2^* = 0.2420 & B_2^* = 0.3745 \\ B_3^* = 0.2451 & B_3^* = 0.3791 \\ \alpha^* = 0.0027 & \alpha^* = 0.0030 \\ I_0^* = 80.852 \times 10^{-40} \text{ gm. cm.}^2 & I_1^* = 73.814 \times 10^{-40} \text{ gm. cm.}^2 \\ r_0^* = 1.889 \text{ \AA.} & r_1^* = 1.805 \text{ \AA.} \end{array}$$

The D -values are of the order of 10^{-7} cm.⁻¹. Full details of this analysis will be published elsewhere.

K. SUBRAMANAYANA RAO

Physics Department,
Andhra University,
Waltair. Feb. 17.

¹ Rao, K. S., *Nature*, **170**, 670 (1952).

Direct Measurement of Intensity Distributions in Star Images

MEASUREMENTS of the distribution of light intensity in the images of a star, formed by lenses, may be made with photomultiplier techniques. The experimental evidence so provided is of immediate application to the theory of the resolution of optical instruments, permitting confirmation of rigorous calculations, for example, those of Airy¹ for the aberration-free axial case; of Martin² for the axial case with aberration and of Hopkins³ for the general case at a position in the field of a system with aberrations. Another use for these measurements is in checking the accuracy of approximate methods of image calculation⁴. Apparatus based on photomultipliers has generally been designed to employ a slit probe, for facility of image location and in order to keep the incident flux at a convenient level. Results have been obtained by Ingelstam⁵, Schade⁶, Lindberg⁷ and Sprosen⁸ in this way, and R. E. Hopkins⁹ has used a circular aperture to measure the proportion of the total energy which falls within a chosen diameter of the image. The measurements made by these means need to be converted by the appropriate mathematical techniques in order to arrive at the requisite distributions. Direct intensity distribution measurements are evidently desirable provided the experimental difficulties of image location and low light level can be overcome.

An experimental arrangement has been developed for use with photographic lenses, having a 'point' probe which is small compared with the star image and which may be translated through sufficiently small distances to enable the image to be charted; facility is also provided for the location of the image. The photoelectric response of the multiplier has been found to be sufficient for this purpose, even at moderate dynode voltages, when using a condensed high-pressure mercury source. The experimental equipment is represented in Fig. 1 and comprises an artificial star, formed by the pinhole *S* and collimator *O*, a test lens *L* which forms an image of the star in the working plane of the microscope objective *O* and the photocell aperture *A* defining the region of the star image from which energy will be received. To the microscope is added a side-tube containing a monitor system; a thin (unsilvered) glass plate *M* and eyepiece *E*, which is set for line and made parafocal with the primary system by a subsidiary optical technique. The field of the eyepiece *E* is provided with a grid graticule so that co-ordinates of the position of the image of *A* in the working plane of *O* and also co-ordinates of the position of the star image are readily specified. Thus the star image is located. The image scan is accomplished by moving the object pinhole *S* through a small distance across axis, using the optical reduction of the collimator and test lens system to provide the very small image displacement required. The probe diameter is taken to be the reduced diameter of aperture *A* in the working plane,

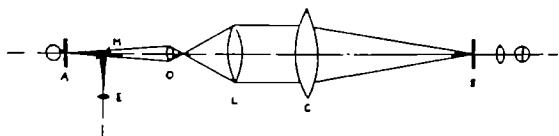


Fig. 1. Experimental arrangement, comprising pinhole *S* illuminated by the source, collimator lens *O*, test lens *L*, microscope objective *O*, beam splitter *M*, receiving aperture *A* and eyepiece *E*.

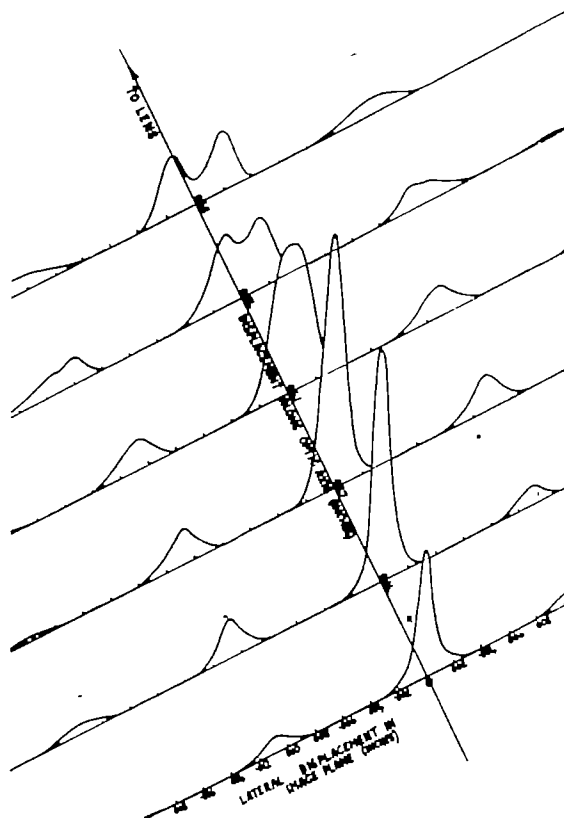


Fig. 2. Intensity distribution in a star image. Cross-sections of the image are shown at several planes near focus. Intensity is shown vertically in arbitrary units.

and without difficulty this may be made less than $1/30$ of the diameter of the star image formed by a photographic lens of moderate or large focal length.

Preliminary work with this apparatus has given satisfactory results for a telephoto lens of 36 in. focal length and aperture $f/8.3$. Star images are commonly of the order of 0.0015 in. diameter in such cases; accordingly the probe diameter was made approximately 0.00005 in. by using an objective of 8 mm. focal length, the aperture *A* having a diameter of about 0.001 in. The object pinhole was moved through a distance of the order of 0.005 in. in the focal plane of a collimator of $3\frac{1}{4}$ times the focal length of the test lens. In Fig. 2 the image cross-sections are shown for a series of transverse planes in the neighbourhood of focus. Intensity is shown in arbitrary units vertically and lateral displacement is shown in intervals of 0.002 in. The traces are shown for planes displaced at equal intervals of 0.0185 in. along a third axis through the origin. These curves present a self-consistent model in agreement with standard results for a lens with appreciable under-corrected spherical aberration¹⁰ and which conforms with the general pattern of distributions calculated for other lenses of the same focal length⁴. In the plane of best instrumental focus, at 0.027 in. along axis from the origin, the central maximum has a half-width of 0.0018 in. and the first ring has a radius of 0.011 in., a comparatively large value. There is also a weak second ring at approximately twice the radius of the first ring. This ring structure cannot be detected visually in the general flare surrounding the image core, as the variations in intensity

are small, and the photoelectric technique seems preferable in such a case. Detailed developments in the apparatus are needed before trying to correlate experimental and theoretical results with the precision desired. At present the reproducibility of results is only 5 per cent, largely because of source fluctuations, the apparatus is inflexible and the taking of readings is tedious. The work, nevertheless, shows that a useful technique for direct intensity distribution measurements may be developed on this principle, and it is hoped that the specification of lens performance may be freed from the restrictions imposed by the present need to depend on photographic recording. A particular application lies in the determination of the significance of the width of the central part of the image.

Acknowledgment is due to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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Royal Aircraft Establishment,
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March 4.

- ¹ Airy, Sir George, *Trans. Camb. Phil. Soc.*, 4, 233 (1834).
² Martin, L. O., "Technical Optics", 1, 125 (Pitman, London, 1948).
³ Hopkins, H. H., *Proc. Roy. Soc., A*, 117, 408 (1953).
⁴ Bracey, R. J. (publication confidential to B.S.I.B.A.). Nash, J. M., and Mathieson, B. M., R.A.E. Technical Notes Ph. 482 and 484, Fig. 11 (1953).
⁵ Ingoulian, R., *Proc. Symp. on Image Evaluation, Nat. Bur. Stands.* (1961).
⁶ Schade, O. H., *J. Soc. Mod. Prod. Tech. Eng.*, 56, 187 (1951); 58, 181 (1952).
⁷ Lindberg, P. J., *J. Opt. Soc. Amer.*, 48, 748 (1952).
⁸ Sprosen, W. N., *B.B.O. Quart.*, 8 (1) (1953).
⁹ Hopkins, H. H., *Proc. Symp. on Image Eval., Nat. Bur. Stands.* (1961).
¹⁰ Martin, L. O., "Technical Optics", 2, 261 (Pitman, London, 1948).

Oxygen Uptake and Carbon Dioxide Evolution of Heat-sterilized Soil

In a study of the respiration of soils at temperatures ranging from 10° to 70° C., it was found that oxygen uptake and carbon dioxide evolution increased with increasing temperature above 50° C.¹ The decline in plate counts at the higher temperatures indicated a gas exchange due to heat-stable enzymes or chemical oxidation and decarboxylation.

An investigation was then made on the gas exchange of soils subjected to various heat-sterilization treatments (Table 1).

These results show that the oxygen uptake increases with increasing severity of heat treatment. This suggests that the effect of heating is to expose oxidizable groups in the soil either by direct re-

Table 1. EFFECT OF HEAT TREATMENT ON GAS EXCHANGE OF SOIL.
(μ l./gm oven-dry soil/hr. at 30° C.)

	Un- treated soil	Heated to 55° C. for 2 days	Steamed for 1 hr. on 3 successive days	Autoclaved at 15 lb./sq. in.		
				1 hr.	2 hr.	3 hr.
O ₂	19	1.4	5.9	7.0	8.5	9.0
CO ₂	18	0.7	1.7	1.2	1.3	1.2
Ratio CO ₂ /O ₂	0.9	0.5	0.29	0.17	0.16	0.14

Table 2. GAS EXCHANGE OF UNHEATED AND AUTOCLAVED SOIL AT 30° C. IN THE PRESENCE OF BIOLOGICAL INHIBITORS
(μ l./gm./hr.)

	Unautoclaved soil				Autoclaved soil			
	No inhibitor	Sodium azide	Sodium chloride	Mercuric chloride	No inhibitor	Sodium azide	Sodium chloride	Mercuric chloride
O ₂	18	2.0	0.9	3.0	18	15	21	20
CO ₂	17	3.0	1.8	2.5	2.9	0.7	1.7	1.9

duction or by the disruption of some fractions of the organic matter. The evolution of carbon dioxide from heated soils at 30° C. was low in comparison with oxygen uptake, but other work² has shown that the ratio of carbon dioxide to oxygen in autoclaved soils increases as the temperature at which respiration is being studied is increased.

The narrow carbon dioxide/oxygen ratio, the non-inhibition by microbial and respiratory inhibitors (Table 2) and the temporary nature of the gas exchange (Table 3) in the heat-sterilized soils are further evidence that the gas exchange is due to chemical oxidation.

Table 3. GAS EXCHANGE AT 30° C. OF AUTOCLAVED SOIL AT VARIOUS PERIODS AFTER HEATING
(μ l./gm./hr.)

	Time after autoclaving (15 lb./sq. in. for 1 hr.)			
	1 hr.	5 hr.	6.5 hr.	9 days
O ₂	25	18	12	0.8
CO ₂	8.6	4.3	3.0	0.6

The gas exchange of soil nine days after autoclaving is probably indicative of the chemical oxidation which occurs in soils at normal temperatures. This oxidation, while not significant in comparison with microbial respiration at normal temperatures, increases with increasing temperature. In exposed inland Australian soils, where temperatures of 47°–60° C. occur at one inch depth for several hours per day during summer months³, the chemical oxidation could be a significant factor in the decline in organic matter.

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Feb. 10.

- ¹ Bunt, J. S., and Rovira, A. D., *J. Soil Sci.* (in the press).
² West, B. S., *Aust. J. Sci. Res., A, Phys. Sci.*, 5, 303 (1952).

Rosette Disease of Groundnuts

ROSETTE disease of groundnuts annually causes great losses in many parts of Africa, and the degree of loss varies considerably. The disease is present in the three areas farmed by the Overseas Food Corporation in Tanganyika. At Kongwa in the Central Province losses are negligible, at Nachingwea in the Southern Province serious, while at Urambo in the Western Province they have been so great that groundnuts are no longer grown.

The vector of the disease is *Aphis craccivora* Koch. In natural bush the vector has been found on about twenty plant species, mostly Leguminosae, at

different times of the year. None of these has yet been proved to be a host of the virus¹. The principal variety of groundnut grown by the Corporation, Natal Common, is a short-season type, the seed of which is able to germinate when the plant is mature. Under suitable conditions of soil moisture volunteer plants from seed left in the ground at harvest provide host plants during the dry season for the vector and also the virus. Thus both vector and virus can survive until the early rains fall and new volunteers appear which soon become infected and are a source of virus for the new crop.

The negligible incidence of the disease at Kongwa is probably due to low rainfall, which usually has ceased by harvest time, so that soil conditions are not favourable for the germination of seed left in the ground. The few that do germinate usually die before the onset of the next rains. At Nachingwea and Urambo conditions are usually favourable for the germination of seed left in the ground and large numbers of volunteers appear, a high proportion of which survive through the dry season, carrying both the virus and its vector. Attempts at eradication of volunteers during the dry season by ploughing or hoeing have not proved satisfactory; on some soil types the soil is so hard that the blades do not penetrate sufficiently to give a good kill. Several operations would prove too costly.

Recent work at Nachingwea has revealed several promising lines of control. The systemic insecticide 'Schradan' used as a seed dressing has given complete control of aphids for the first three weeks in the life of the plant and also reduced the initial incidence of the disease, presumably by killing incoming infective winged aphids before they could infect several plants.

In a variety trial in 1951, Mwitunde appeared to show some resistance. In a similar trial in 1952 two strains of this variety showed considerably less disease than the other twenty-three varieties and gave the highest yields. A small area planted with these two strains for selection purposes showed only a few plants infected, while an adjacent area planted with other varieties was badly infected. Mwitunde seed was planted in a recently sown field of Natal Common. The resulting plants and some Natal Common plants were infested with infective aphids nine days after emergence. Two weeks later, the percentage of Mwitunde plants free from aphids, 34 per cent, was significantly higher than that for Natal Common, 14 per cent. The spread of infective aphids was measured by the number of Natal Common plants adjacent to the test plants that showed rosette. The spread from Natal Common was nearly six times higher than that from Mwitunde, the difference being highly significant.

The mechanism of this resistance has been investigated. Tests showed that when infested experimentally with infective aphids, Mwitunde was infected to the same extent as other varieties. Thus it appeared that its resistance was due to some difference in the behaviour of the vector on it. Field studies and laboratory tests showed that *A. craccivora* had no marked preference for other varieties over Mwitunde. In a series of experiments the rate of reproduction of the aphid on Mwitunde was highly significantly less than on Natal Common, being approximately only one-third. An explanation can now be offered for the higher percentage of uninfested plants of Mwitunde as compared with Natal Common. Coccinellid and syrphid predators, which are numerous

locally, were able to exterminate a higher percentage of colonies on Mwitunde because of their lower rate of increase. This resistance factor is only of value in areas where a suitably high predator population occurs, since although the rate of reproduction is comparatively low on Mwitunde, it is sufficiently rapid to cause loss of crop unless predators are present.

The more rapid extermination of colonies on Mwitunde only partly explains the lesser spread of disease on this variety. Tests of the percentages of aphids able to transmit rosette when reared on Mwitunde and Natal Common showed great variation in the degree of infectivity; but it was always lower on Mwitunde.

Percentage of infective aphids from		
Natal Common	Mwitunde	
31	0	P = 0.01
6	0	P = 0.05
51	32	P = 0.01
35	16	P = 0.01

The fourth experiment was designed to test differences in the infectivity of aphids from different plants as well as between varieties. There were highly significant differences between plants for both varieties, the range for Natal Common being 8-71 per cent, and for Mwitunde 0-32 per cent, suggesting that this resistance factor might be present to some degree even in such a uniform variety as Natal Common.

A third factor is being studied. In two instances where Mwitunde was so badly rosetted that ploughing in was considered, the yield proved to be 660 and 710 lb. of pods per acre compared with 1,040 lb. for a field much less severely rosetted. This suggests that the variety may have some tolerance to the virus.

Mwitunde possesses a further valuable characteristic, that of seed dormancy. The seed does not germinate until about ten weeks after the crop has reached maturity. By the time this dormant period has passed, the soil has dried considerably and only an occasional seed germinates. Thus there is an effective break in the carry-over of virus and vector from one crop to the next.

Mwitunde is a very mixed variety, showing great variation in size of plant, in habit, from prostrate to erect, and in pod and kernel characters. Thus the possibility of selecting a strain showing high yielding capacity together with a field resistance to rosette greater than that shown by the variety as at present constituted appears promising.

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Tanganyika Territory.
Feb. 19.

¹ Story, H. H., Annual Report, East African Agriculture and Forestry Department, 35 (1952)

Life-history of *Porphyra*

In a recent publication¹, Kurogi reports the existence of a *Conchocelis*-phase in the life-history of four Japanese species of *Porphyra*. He confirms my observations on the germination of the spores liberated from thalli of *P. umbilicalis* v. *laciniata* as first reported in *Nature*² and described more fully in a recent publication³. Thus, the existence of a *Conchocelis*-phase in the life-history of species of *Porphyra* appears general. It also appears that the

Conchoecelis-phases of various species of *Porphyra* are very similar. As might be expected, the *Conchoecelis*-phase of *Bangia*⁴, a description of which is being prepared for publication, shows slight differences.

Fertile cell-rows develop on the *Conchoecelis*-phase in abundance and the next step in the elucidation of the life-history consists in showing how these spores are liberated and into what type of thallus they develop. Kurogi¹ shows they are liberated into the culture solution in great profusion², thus confirming my view and not that held by earlier investigators³ who supposed they were liberated laterally from each cell into the shell. Kurogi observed and figures the very early stages in the germination of these spores in all four species, *P. tenera* Kjellm., *P. suborbiculata* Kjellm., *P. umbilicalis* (L.) J.Ag. proz. and *P. pseudolinearis* Ueda. The method of germination of these spores is quite different from those which give rise to the *Conchoecelis*-phase and consists (excepting those of *P. umbilicalis*, proz.) of a very short row of quadrate cells. The cell contents are not indicated. Those of *P. umbilicalis* proz. show longitudinal division in the apical cell at a very early stage and they soon become obovate. None of the germings figured has more than fifteen cells, the majority fewer. Kurogi concludes that the spores liberated from the *Conchoecelis*-phase "germinated into such a bud of the leafy thallus of *Porphyra* as is found in the sea and they did not penetrate again into the shells".

If, in fact, these germings had been grown on and had developed into the leafy *Porphyra* thallus, it would appear that either the life-histories of different species of *Porphyra* may be variations of a basic type, or that the life-history of a given species may not always follow the same course. For one thing, the occurrence of 'plantlets' of considerable size and vigour, with every character of an independent phase, has been demonstrated already in the life-history of *P. umbilicalis* v. *laciniata*^{3,4}. Moreover, a further experiment I have carried out has demonstrated that sterile shells introduced into a

culture vessel containing shells 'infected' with the *Conchoecelis*-phase of this species themselves become 'infected' with the *Conchoecelis*. The first sterile shell to be introduced were in contact with the 'infected' ones; but subsequent sterile shells were suspended, by means of nylon thread, in such a way that they touched neither the vessel nor the 'infected' shells. Still they became 'infected' with *Conchoecelis*. In some cases the points of 'infection' were very numerous, as in the shell figured (Fig. 1). This shell was introduced into the culture vessel on February 27, 1953, and photographed on April 20, 1953. The culture used had been started in mid-November 1952. Similar experiments with the same results have been carried out with the *Conchoecelis*-phase of *Bangia fuscopurpurea* from Naples. It is clearly necessary to establish the method by which the spread of the *Conchoecelis*-phase from one shell to another has taken place, whether by vegetative filaments or spores, and if spores, whether there are two types of spores formed as appears possible on the basis of Kurogi's observations and those now reported.

It is certain that there is still much to be learned about the life-history of *Porphyra*.

KATHLEEN M. DREW

Department of Cryptogamic Botany,
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June 4.

¹ Kurogi, M., Bull. Tôhoku Reg. Fish. Res. Lab. No. 2, 67 (1953).

² Drew, K. M., *Nature*, 164, 748 (1949).

³ Drew, K. M., *Ann. Bot.*, N.S., 18, 183 (1954).

⁴ Drew, K. M., *J. Linn. Soc. (Bot.)*, 55, 84 (1953).

⁵ Kurogi, M., Bull. Tôhoku Reg. Fish. Res. Lab. No. 2, 104 (1953).

⁶ Rosenqvist, L. K., *Dansk Vidensk. Selsk. Skrift. VII. Mat.-nat. Afd.*, 7 (1900-51).

⁷ Jao, C. C., *Papers Mich. Acad. Sci. Arts, Letters*, 28, 111 (1937).

⁸ Drew, K. M., *Proc. 7th Inter. Bot. Cong.*, 1950, 835 (1953).

A Rare Fungus in Surrey

On October 24, 1953, I was fortunate in collecting an example of the rare fungus *Batiarraea phalloides* (Dicks) Pers. The locality was Drud's Grove, Boxhill, and it was growing at the base of one of the large old yew trees which are a feature of that particular area. The specimen was rather small (9 cm. tall), as most records mention about one foot in height. Very few specimens have been recorded since it was first described by Thomas Woodward in 1784.

Dr. J. Ramsbottom, who deals extensively with this species in his recent book "Mushrooms and Toadstools", remarks that it is surprising that it is known with certainty elsewhere only from one locality in France and one, or perhaps two, in Italy. Incidentally, he also states that the last British record was from Temple Guiting, Gloucestershire, in 1915; but it now transpires that an example was found at the base of an elm trunk (in a hedgerow) at Callow Hill, near Virginia Water, Surrey, by Miss Notley on November 1, 1944, and is now at the Royal Holloway College.

My Boxhill specimen has been handed over to Mr. J. T. Palmer, who has kindly undertaken a revision of the British Gasteromycetes on behalf of the British Mycological Society.

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March 8.



Fig. 1. Sterile shell suspended in culture vessel containing shells 'infected' with the *Conchoecelis*-phase of *Porphyra umbilicalis* v. *laciniata* on February 27, 1953, and photographed April 20, 1953. Note the numerous areas of 'infection' by *Conchoecelis* now clearly visible. The dark linear areas in the fluting at the edge of the shell are mostly due to diatoms. Nat. size

FORTHCOMING EVENTS

(Meeting marked with an asterisk * is open to the public)

Monday, June 28—Friday, July 2

ROYAL INSTITUTE OF CHEMISTRY (at the University, St. Andrews)—Symposium on "Recent Advances in the Chemistry and Industrial Applications of Cellulose".

Wednesday, June 30

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 4.45 p.m.—Dr. Alfredo Massimo: "The Steam Vents of Tuscany". Exhibits relating to the Pliocene problem by Mr. A. T. Marston; Prof. W. M. Le Gros Clark, F.R.S., and Dr. J. S. Weiner; Mr. S. H. V. Bowie and Dr. O. H. Davidson; Dr. G. F. Clarnbull and Dr. M. H. Hey; Dr. K. P. Oakley.

INSTITUTE OF METALS (at 4 Grosvenor Gardens, London, S.W.1), at 5 p.m.—Prof. H. Orowan, F.R.S.: "The Brittle Fracture of Metals: Some New Developments".

Thursday, July 1

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. H. B. Scott (McMaster University): "The Influence of Aerial Methods on the Evolution of Geological Reconnaissance".

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at the Royal Institution, Albemarle Street, London, W.1), at 6 p.m.—Dr. Karl Darrow: "Some Current Work at Bell Telephone Laboratories".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (with veterinary qualifications) in ANIMAL PHYSIOLOGY AND ANIMAL HEALTH in the Department of Agriculture (Animal Husbandry)—The Registrar, University College of Wales, Aberystwyth (June 30).

UNIVERSITY DEMONSTRATOR IN PHYSICAL ANTHROPOLOGY at the University of Cambridge—The Secretary of the Appointments Committee, Faculty of Archaeology and Anthropology, Downing Street, Cambridge (June 30).

SCIENTISTS (with a good honours degree or equivalent, in engineering or physics, and with relevant postgraduate experience in any of the following fields: light engineering development, pneumatic and/or hydraulic mechanism design, design of light electromechanical mechanisms, optical mechanisms), at the National Coal Board Central Research Establishment II, Isleworth, Middlesex, to undertake fundamental research into the underground problems arising in the mining of coal—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/791 (July 1).

ASSISTANT LECTURER IN BACTERIOLOGY—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (July 3).

ASSISTANT LECTURER (qualified to teach the history of modern philosophy) of PHILOSOPHY—The Registrar, University College of North Staffordshire, Keele, Staffs. (July 3).

ASSISTANT (with a recognized qualification in microbiology or training or experience in microbiological methods) in MICROBIOLOGY at Long Ashton Research Station—The Secretary, Research Station, Long Ashton, Bristol (July 3).

EXPERIMENTAL OFFICERS or ASSISTANT EXPERIMENTAL OFFICERS (with H.S.C. (science) or equivalent; a pass degree in mathematics or experience in computing, aerodynamics, statistics, etc., an advantage), at Ministry of Supply Experimental Establishments in or near London, for computational work connected with performance of armaments and aircraft, supervision of a small group of assistants and some responsibility for the development of new computing techniques—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.164/54A (July 3).

LECTURER IN ENGINEERING—The Registrar, University College of South Wales and Monmouthshire, Cathays Park, Cardiff (July 3).

RESEARCH ASSISTANT IN THE DEPARTMENT OF PURE MATHEMATICS—The Registrar, The University, Liverpool (July 3).

RESEARCH DEMONSTRATOR IN ZOOLOGY—The Registrar, The University, Sheffield (July 3).

SENIOR TECHNICIAN IN THE DEPARTMENT OF PHYSICS, University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 3).

LECTURER, Grade A (with a good honours degree) in PHYSICS at Kuman College (Gold Coast College of Technology, Science and Arts)—The Secretary, Advisory Committee on Colonial Colleges, 1 Gordon Square, London, W.C.1 (July 4).

LECTURER (with a degree or a recognized diploma in mining) in THE DEPARTMENT OF MINING AND GEOLOGY—The Principal, Wigan and District Mining and Technical College, Wigan (July 6).

PRINCIPAL OF SOUTHEAST TECHNICAL COLLEGE, Southall, Middlesex—Chief Education Officer (F/CW/2), Middlesex County Council, 10 Great George Street, London, S.W.1 (July 6).

ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, The University, Sheffield (July 7).

CHAIR OF CHEMISTRY at Makerere College (University College of East Africa)—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 10).

LECTURER and an ASSISTANT LECTURER in THE DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Manchester 13 (July 10).

ASSISTANT LECTURER IN CHEMISTRY—The Registrar, Wye College, near Ashford, Kent (July 12).

SCIENTIFIC OFFICER (with a good honours degree in botany or agricultural botany, and an interest in fruit culture) in THE DEPARTMENT OF POMOLOGY, for research into the growth and development of soft fruit plants, principally the raspberry, and an EXPERIMENTAL OFFICER in THE VEGETABLE CULTURES SECTION, to assist with a plant breeding programme for varieties suited to Scottish conditions—The Secretary, Scottish Horticultural Research Institute, Mylnfield, Invergowrie, by Dundee (July 15).

LECTURER or RESEARCH ASSISTANT IN BACTERIOLOGY AND VIRUS DISEASES—The Registrar, The University, Sheffield (July 17).

RESEARCH FELLOW IN PURE MATHEMATICS—The Registrar, The University, Edgbaston, Birmingham (July 17).

SENIOR LECTURER (preferably qualified and willing to develop research in geochemistry) in GEOLOGY at the University of Melbourne, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, July 19).

CHAIR OF EDUCATION at the University of Adelaide, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, July 30).

PROFESSOR OF GEOPHYSICS—The Director, Institute of Astronomy, Helwan, Egypt (July 31).

PROFESSOR OF PHYSICS at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, July 31).

ASSISTANT HISTOLOGIST (Senior Scientific or Scientific Officer grade) in THE BEE RESEARCH DEPARTMENT, for work on bee breeding and the pollination of crops—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

CHEMIST (with a degree in natural science, and preferably with postgraduate experience, particularly in soil survey work) in THE AGRICULTURAL DEPARTMENT, Sierra Leone, to make a soil survey of part of the Northern Province of Sierra Leone, with particular reference to the nutrient status and fertilizer requirements of soils suitable for mechanized rice cultivation—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting CDE.63/15/04.

CHEMIST (with an honours degree and preferably with some knowledge of food analysis) for research and analytical work in connection with the study of problems of fruit and vegetable preservation—The Director, Fruit and Vegetable Canning and Quick Freezing Research Association, Research Station, Chipping Campden, Glos.

DEMONSTRATOR IN PHYSICS—The Registrar, The University, Nottingham.

ENGINEERS, SCIENTISTS and ARCHITECTS (with an aptitude for committee work), to act as Secretaries to Committees dealing with a variety of subjects—The Establishment Officer, British Standards Institution, 2 Park Street, London, W.1.

EXPERIMENTAL OFFICERS (with at least H.S.C. (science) or equivalent, and preferably with a pass degree in chemical engineering or applied chemistry), or ASSISTANT EXPERIMENTAL OFFICERS (with at least H.S.C. (science) or equivalent), to assist in chemical engineering investigations and development work—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 74/W.G.B./84.

LECTURER IN EDUCATION at the University of Tasmania—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1.

LIVESTOCK RESEARCH OFFICER (with a good honours degree in agriculture or equivalent, and at least four years postgraduate experience in field experimentation and tropical agriculture, with particular reference to pasture management and animal husbandry), at Ebin Livestock Experimental Station, British Guiana, for duties which will include the planning and supervision of research and other projects for the purpose of ascertaining the most economic methods of developing the minerally-derivative savannahs of the area—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BOD 87/80/01.

MATHEMATICIANS, SCIENTIFIC OFFICERS, ASSISTANT EXPERIMENTAL OFFICERS or EXPERIMENTAL OFFICER grades, at Ministry of Supply Research and Development Establishments, mainly in Southern England, for work in problems chiefly concerned with aircraft, radio and radar equipment and armaments—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.141/54A.

RESEARCH ASSISTANTS (with a good honours degree in physics, and preferably with previous experience in solid state physics) in THE PHYSICS DEPARTMENT—The Professor of Physics, University of Reading, Physics Research Laboratories, 78 Upper Redlands Road, Reading, Berks.

SCIENTIFIC OFFICERS, CHEMISTS and CHEMICAL ENGINEERS (with a first- or second-class honours degree in chemistry, physics or chemical engineering or equivalent qualification, and preferably with experience in one of the following: (a) Infra-red spectroscopy in the field of organic chemistry; (b) development of new methods and application of physico-chemical techniques in an analytical laboratory with an organic bias; (c) organic chemistry, particularly with the synthesis of fluoro derivatives or organic compounds; (d) development of laboratory methods of organic synthesis to pilot plant scale), at the Atomic Weapons Research Establishment, Aldermaston, Berkshire—The Administrative Officer (Recruitment), A.W.R.E., Aldermaston, Berks, quoting 112/W.G.B./2.

SENIOR SCIENTIFIC OFFICER or SCIENTIFIC OFFICER (with a first- or second-class honours degree in mathematics or physics, or equivalent qualifications, and for the senior post at least three years postgraduate research experience), to work on theoretical problems with meteorological applications—The Administrative Officer (Recruitment), Atomic Weapons Research Establishment, Aldermaston, Berkshire, quoting 149/W.G.B./34.

TECHNICAL LIBRARIAN AND INFORMATION OFFICER (Chartered Librarian with considerable experience in industrial libraries, and preferably with a technical or scientific qualification), to establish and develop an information department and library in an important industrial organization in the Midlands—The Director, Ashby, 4 Palace Gate, London, W.8.

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TOBACCO RESEARCH OFFICER (with a good honours degree in botany, agricultural botany or agriculture, and at least two years postgraduate training and experience in field experimentation and crop husbandry generally) in the Department of Agriculture, Nyasaland, to carry out experimental work on tobacco growing and curing, under the general direction of a tobacco expert—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting ODR.63/4/04

REPORTS and other PUBLICATIONS

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Great Britain and Ireland

- Department of Scientific and Industrial Research and Fire Offices' Committee. Fire Research Bulletin No. 1: Fire and the Atomic Bomb. By D. I. Lawson. Pp. vi+30. (London: H.M. Stationery Office, 1954.) 2s. 6d. net. [304]
- Library Association. Year Book, 1954. Pp. lxxviii+476. (London: Library Association, 1954.) 21s. (16s. to members.) [304]
- Department of Scientific and Industrial Research. Road Research Laboratory. Road Research Technical Paper No. 29: The Use of Stabilized Soil for Road Construction in the U.S.A. By K. E. Clarke. Pp. vi+26+16 plates. (London: H.M. Stationery Office, 1954.) 2s. 6d. net. [304]
- British Electrical and Allied Industries Research Association. Thirty-Third Annual Report—1st January, 1953 to 31st December, 1953. Pp. 160. (Leatherhead. British Electrical and Allied Industries Research Association, 1954.) [304]
- Discussions of the Faraday Society. No. 16, 1954: The Physical Chemistry of Dyeing and Tanning. Pp. 256+4 plates. (London: Faraday Society, 1954. Agents: Aberdeen University Press.) 35s. net. [35]
- Universities Council for Adult Education. Report on the year 1952-1953. Pp. 38. (Bristol: W. B. Salt, The University, 1954.) [35]
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- Contributions from the Armagh Observatory. No. 9: A Climatological and Astronomical Interpretation of the Ice Ages and of the Past Variations of Terrestrial Climate. By E. J. Opik. Pp. 79. (Armagh: Armagh Observatory, 1953. Agents: B. H. Blackwell, Ltd., Oxford.) 10s. 6d. net. [35]
- School of Cosmic Physics. Dublin Institute for Advanced Studies. Geophysical Bulletin No. 8: Convective Transfer in the Problem of Climate. By E. J. Opik. Pp. 14. (Dublin: School of Cosmic Physics: Dublin Institute for Advanced Studies, 1953.) 2s. 6d. [35]
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Other Countries

- Science Reports of the Tohoku University, Sendai, Japan. Second Series (Geology), Vol. 25: The Geology of Sendai and its Environs. Edited by Shoburo Hanawa, Kotora Hatai, Jun-ichi Iwai, Nobu Kitamura and Toyochichi Shibata. Pp. 50+2 maps and 4 charts. (Sendai: Tohoku University, 1953.) [304]
- East Africa High Commission. East African Marine Fisheries Research Organization. Annual Report, 1952. Pp. 12. Annual Report, 1953. Pp. 26. (Nairobi: East Africa High Commission, 1953 and 1954.) [304]
- International Scientific Radio Union. Special Report No. 3. Discrete Sources of Extra-Terrestrial Radio Noise. Pp. 56. (Brussels: International Scientific Radio Union, 1954.) 75 Belgian francs; 11s.; 1 dollar 4 cents. [304]
- U.S. Department of Commerce. National Bureau of Standards. Handbook 55: Protection Against Beta-Ray-Synchrotron Radiations up to 100 Million Electron Volts. Pp. vi+52. (Washington, D.C. Superintendent of Documents, 1954.) 25 cents. [35]
- Metropolitan Life Insurance Company. Statistical Bulletin, Vol. 35, No. 3 (March 1954): Some Aspects of the Baby Boom. Pp. 12. (New York: Metropolitan Life Insurance Company, 1954.) [35]
- Annals of the New York Academy of Sciences. Vol. 56, Art. 7: Mathematical Deductions from Empirical Relations Between Metabolism, Surface Area, and Weight. By Herman von Söbeling. Pp. 1143-1194. 1 dollar. Vol. 57, Art. 4: Branched Molecules. By F. B. Reich and 18 other Authors. Pp. 325-450. 3.50 dollars. Vol. 57, Art. 5: Parental Age and Characteristics of the Offspring. By L. O. Strong and 21 other Authors. Pp. 451-614. 3.50 dollars. Vol. 58, Art. 1: Neurotoxic Interference with Two Human Strains of Poliomyelitis in Rhesus Monkeys. By Murray Sanders, Manuel G. Soret and Benjamin A. Akin. Pp. 12. 50 cents. Vol. 58, Art. 2: Basic Odor Research Correlation. By A. B. Behnke and 33 other Authors. Pp. 13-200. 3.50 dollars. (New York: New York Academy of Sciences, 1953 and 1954.) [35]
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- Museum of Comparative Zoology at Harvard College. Breviora. No. 31 (March 3, 1954): New Freshwater Gastropod Mollusks of the African Genus *Lamellae*. By T. P. P. 4. No. 32 (March 12, 1954): Fossils and the Distribution of Chelydrid Turtles. 2. Additional Reported Chelydrid Turtles on Northern Continents. *Palaeosaurus conchyliarius* (Owen)—a Pelomedusid. By Ernest Williams. Pp. 6. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) [35]
- Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. 111, No. 3: Random Notes on North American Carabids (Coleopt.). By Carl H. Lindroth. Pp. 117-162. Vol. 111, No. 4: Chirotherium Lullii, a Pseudoscorpion Reptile from New Jersey. By Donald Baird. Pp. 163-168+2 plates. Vol. 111, No. 5: The Spider Genus *Mangora* (Araneidae) in Panama. By Arthur M. Chickering. Pp. 193-216. Vol. 111, No. 6: Exotic Earthworms of the United States. By G. E. Gates. Pp. 217-258. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1954.) [35]
- Annual Report of the Director of the Museum of Comparative Zoology at Harvard College, 1952-1953. Pp. 24. (Cambridge, Mass.: Museum of Comparative Zoology at Harvard College, 1953.) [35]
- Chronicle of the World Health Organization. Vol. 8, No. 2-3 (February-March 1954): Trepanomastosis—a World Problem. Pp. 37-114. (Geneva: World Health Organization; London: H.M. Stationery Office, 1954.) 2s. 6d.; 0.50 dollars, 2 Swiss francs. [35]
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- American Philosophical Society. Year Book 1953, January 1, 1953-December 31, 1953. Pp. 517. (Philadelphia: American Philosophical Society, 1954.) [106]
- On the Congruence of Sets and Their Equivalence by Finite Decomposition. By Prof. Wacław Sierpiński. (Ludchow University Studies No. 20. Faculty of Science, Season 1948-49.) Pp. v+117. (Ludchow: Ludchow University, 1954.) [106]
- Foreign Trade Zones in the U.S.A. Report of a Group of European Experts. (Technical Assistance Mission No. 28.) Pp. 68. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1954.) 240 French francs; 4s. 6d. net; 0.75 dollars. [106]
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- Smithsonian Miscellaneous Collections. Vol. 122, No. 11: A Revision of the Sea-Stars of the Genus *Tethysar*. By A. M. Clark and Austin H. Clark. Pp. u+27+12 plates. (Publication 4147.) (Washington, D.C.: Smithsonian Institution, 1954.) [110]
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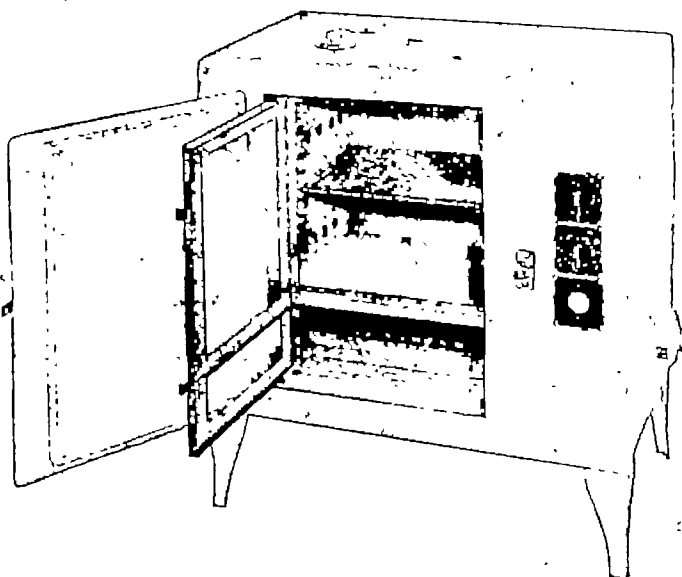
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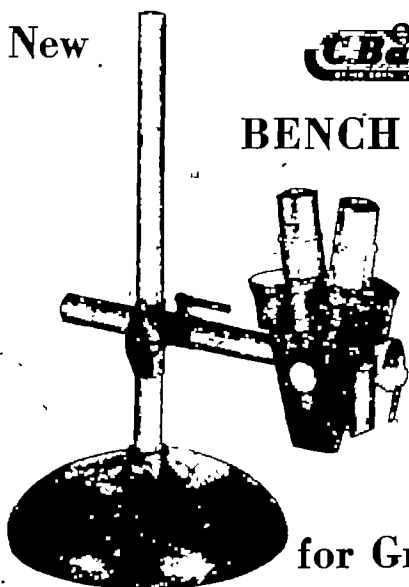
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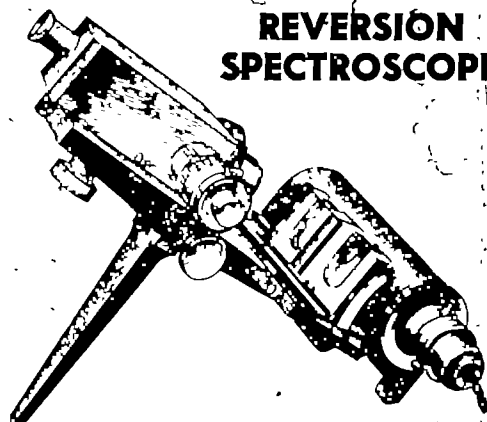
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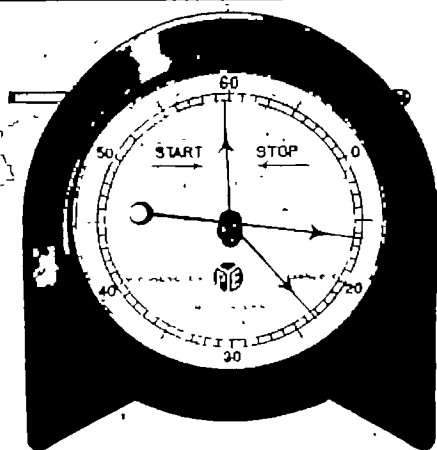
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